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A Breeding Problem of Sheep in the South-West Division of Western Australia.

By H. W. Bennetts, E. J. Underwood and F. L. Shier.

DURING the past few years a specific breeding problem in the ewe has assumed very serious proportions throughout the areas of early-subterranean clover pasre development in this State. It is not confined to the Merino breed, but this breed predominantly affected. The problem has three manifestations, infertility, ystokia ("dead lamb trouble") and a prolapse of the womb (uterus) which nerally occurs some months after the lambing season and which may affect even nbred animals. Analogous conditions do not appear to have been described reviously in veterinary literature and have not been reported from outside this ate except for some isolated occurrences recently met with on Kangaroo Island, nd in other parts of South Australia which have been reported by McKenna 944 and 1945).

On present evidence occurrences appear to be associated exclusively, or almost clusively, with pastures of the locally developed Dwalganup strain of early-bterranean clover.

Rams bred and maintained on "affected" properties have not been found to ow any apparent abnormalities. The castrated male and the unbred female, wever, may exhibit extraordinary phenomena which throw some light on the ture of the problem under consideration. Wethers, not uncommonly, may crete milk or show extraordinary "feminine" changes in their sex organs; marked der development and copious milk secretion are quite commonly seen in maiden unbred females.

Following field and laboratory studies in 1943, reported by Bennetts (1944), e complexity and serious import of the breeding problem was realised and a ore intensive attack was planned.

An Investigation Committee, comprising Dr. L. B. Bull and Mr. A. J. Vasey, the Animal Health and Production Division of the Council for Scientific and dustrial Research, and the three authors was formed early in 1944 and has since rected the co-operative investigation being carried out on a comprehensive scale a team of workers in this State.

Bennetts, H. W. (1944)—J. Agric. Wost Aust., 21 : 40.
McKenna, C. M. (1944 and 1945).—Private communications.

The cause is, of course, unknown, although it may be suggested that the infertility and dystokia result from hormone imbalance related, in some way, to effects of depasturage on the early strain of subterranean clover, *Trifolium subterranean L.* var. Dwalganup. The hormones referred to are chemical substances produced in certain glands of the body which control reproductive processes.

The data given in this paper are based on information from some seventy properties throughout the affected area and on experimental evidence which will be detailed in later publications. Most of the properties concerned have been visited by us, many on different occasions during 1943-45, and on several properties field experiments have been carried out during the period specified.

1.—DEFINITION.

Infertility.—This condition is an infertility of the ewe occurring on subterranean clover pastures, in association with dystokia or prolapse, or with both and is characterised by failure to breed, despite repeated services by known fertile rams, and by an abnormality known as cystic endometrium, which means a cystic condition of the lining of the uterus. The infertility appears to result from the ovum or egg not being fertilized by the ram's sperm.

Dystokia.—The condition referred to is a maternal dystokia which results apparently from inactivity of the uterus, and is characterised typically by lack of evidence of external signs of imminent lambing and by the death of the full term foetus. In some instances lambs are born dead, but more commonly, the foetus is not delivered, and may be dead for some days before it can be seen externally.

Prolapse.—The condition referred to is a prolapse of the inverted uterus proceeding to complete inversion (turning inside out) which occurs typically, some months after the lambing season. Ewes not bred that season or even young virgin females may be affected.

2.—OCCURRENCE, DISTRIBUTION AND ECONOMIC IMPORTANCE.

The three manifestations, infertility, dystokia and prolapse, are closely associated in their occurrence and distribution throughout the affected region, but there is considerable variation in their relative and absolute economic importance on individual properties.

The development of the problem on a property may be heralded by the dramatic appearance of dystokia followed by infertility. Less commonly the first evidence is an insidious appearance of infertility or prolapse. All three manifestations may, in some cases develop serious proportions at the same time, although a high incidence of prolapse is rare.

Whatever the onset, however, the inevitable result appears to be that within a shorter or longer period of years, the infertility becomes progressively more serious until breeding is discontinued as unprofitable. The nature of this infertility had not been studied nor was its relationship clearly defined when Bennetts (*loc. cit.*) studied the more dramatic manifestations of dystokia and prolapse.

Although a few individual properties were known to be affected for some time prior to 1941 it was not till then that there was much evidence of a serious problem developing in the clover areas. The breeding problem thereafter has become progressively more serious and widespread. It is now general throughout the whole area of early-subterranean clover development from as far south as

Mt. Barker, Boyup Brook and Kojonup, west of the Great Southern railway to Beverley in the north. This is the main area affected, but there are increasing occurrences in an area immediately north of Perth, and again in the Geraldton district 300 miles north of Perth. In both these areas early-subterranean clover pastures are well developed. Present evidence indicates that the problem may be expected in any area where early-subterranean clover pastures are well established. It is true that there are still some properties within the area with good clover pastures, developed for varying periods of time, which, as yet, show little or no evidence of a breeding problem. On the other hand experience suggests that none of these properties can be regarded as "immune."

The economic aspects of the problem are extremely serious. Not only is there a heavy annual loss from wastage of ewes and lambs in ordinary farm flocks, which virtually rules out sheep breeding, but the affected areas contain many of the best stud Merino flocks in Western Australia. The loss of valuable animals from these flocks will have serious effects on the productivity of sheep throughout the State. In addition considerable areas of virgin and undeveloped country exist throughout the affected region, and which are capable of very great development. Pasture improvement and development of such country is being held up pending a practical solution of the breeding problem. There are already approximately two million sheep carried within the affected region of which about 50 per cent. are breeding ewes. These are principally Merinos, but large numbers of crossbred and other breeds of sheep also exist.

3.—TYPE OF COUNTRY AND METHODS OF HUSBANDRY.

No detailed soil surveys of the affected areas have yet been made, but it is evident that the soil types vary considerably and range from what are popularly known as "light" soils of low fertility to much heavier soils, producing excellent cereal crops, and which previously were regarded as very "sound" for stock. The main affected area south of Perth, where the incidence of the breeding problems is most intense, carries Wandoo (*Eucalyptus redunca* var. elata) as its principal timber.

The soils are generally grey sandy or gravelly types. In the affected area north of Perth the clover development may be either on typical "sand plain" soils which normally carry little or no grazing, or on heavier textured red-brown soils carrying York Gum (*Eucalyptus foecunda*, var loxophleba) and jam (*Acacia acuminata*).

The average annual rainfall over most of the area is about 20 inches, most of which falls between May and October. Until recent years there was little improved pasture and the type of husbandry was either Merino-sheep grazing over extensive areas, or cereal growing and grazing of sheep on stubbles and "volunteer" pastures. These pastures consisted largely of relatively unproductive annual species such as capeweed (*Cryptostemma calendulaceum*), wild geranium (*Erodium botrys*), *Bromus spp., Festuca spp.,* and a number of small clovers. With the introduction of the early (Dwalganup) strain of subterranean clover about fifteen years ago, and on an increasing scale ever since, a marked improvement in the pastures has taken place and an enormous increase in productivity of the area. This strain of clover has proved to be extraordinarily well-adapted to the environment. It appears to require only regular treatment with superphosphate to make luxuriant growth. Over much of the area the pastures are now completely dominated by subterranean clover and in many cases the rest of the plant species together contribute less than five per cent. of the total weight of herbage.

As a result of this remarkable development of clover pasture the farm husbandry of the area has been revolutionised. Productivity has been trebled or quadrupled, very little cereal cropping is now carried out, and the stock are maintained almost exclusively on the clover pastures, supplemented in some cases by clover hay during the summer and autumn months. Merino sheep, many of the flocks of very high quality, are the principal stock carried. There is little fat-lamb raising from crossbred ewes, but baby-beef production is becoming increasingly popular.

4.—INCIDENCE.

As indicated earlier the relative incidence of the three manifestations of the breeding problem varies considerably from property to property and from time to time although the general progress is towards a high degree of infertility reached within a few years of the first appearance of trouble.

Quite commonly the incidence of dystokia is, at some period, high, accounting for the death of 30-40 per cent. of lambs carried to full term and for the death of 15-20 per cent. of all ewes mated. The incidence in the more susceptible age groups, notably ewes first mated at 2½ years, may be considerably higher, e.g., a 70 per cent. lamb and a 40-50 per cent. ewe mortality. There is, of course, a considerable additional ewe wastage due to retained foetus or inflammation of the uterus or both resulting in general ill-health and loss of breeding capacity.

The incidence of the infertility, in affected flocks shows a general tendency to increase progressively from year to year resulting in a reduction of lambing percentage, estimated at tailing, from the normal of about 80 to about 30 per cent. or even to less than 10 per cent. Breeding operations are often relinquished before such a low stage of fertility is reached.

The incidence of prolapse is rarely as serious although in some flocks it has reached 10-12 per cent. and has constituted the principal or only phase of the breeding problem experienced for one or two years. More commonly the yearly incidence is from less than 1 to 2 per cent.

(*i*) *Seasonal Occurrence, Yearly Variation and Pasture Condition.*

Infertility, dystokia and prolapse only became manifest as a general problem in the areas of early-subterranean clover development subsequent to 1940; the initial rapid extension of the problem in 1941-1943 coincided with the occurrence of three unusually good seasons favourable to a prolific and dominant growth of clover, and an exceptionally prolonged green-feed period. It was at first thought that such conditions directly influenced the incidence of infertility and dystokia. Subsequent experience during the years 1944 and 1945, when the seasons have been shorter and less favourable has failed to confirm this view; during these last two seasons there has been a progressive deterioration in lambing percentages due to infertility and dystokia on individual properties previously affected, as well as a marked extension to properties previously unaffected. There is some evidence however that "good clover years" favour the incidence of prolapse, which condition occurs principally in the spring, viz. from late August till the feed dries off in October. In some years it occurs as early as July and occasional cases are seen throughout the summer, but an examination of some of these suggests that they are recurrences of earlier cases which had not progressed or had "recovered" spontaneously.

With regard to the influence of pasture composition on the incidence of infertility, dystokia and prolapse the earliest and most severe incidence was on properties where subterranean clover was the dominant, or almost exclusive, pasture

species, and it was considered that clover dominance was an essential feature of the problem. It has become evident recently, however, that the same breeding problem is developing, although not yet to the same degree, on pastures less highly improved or in less favourable environments, where early subterranean clover constitutes as low as 30 per cent. of the general herbage on the property. Even in these cases however it cannot be asserted that the sheep have not had access to clover dominant pastures during some periods of their life, as the pasture composition varies considerably on different parts of the property and in different seasons.

The age of establishment of subterranean clover pastures appears to have little relationship to the occurrence of the problem. On some properties pastures have been established for ten years or more before any disease in the sheep became manifest, whereas in other cases the breeding problem has become evident in its various phases within a year or two of the sowing of subterranean clover.

It is notable that the subterranean clover is palatable to sheep only in the mature and dry stages. On dominant pastures, however, the sheep must of necessity subsist almost exclusively on this plant throughout the year. The palatability of the clover burr itself appears to vary in different localities; on some properties it is relished, on others "sheep will starve rather than eat it."

(*ii*) *Species of Animals Affected.*

The sheep, so far, is the only species of farm animal known to be affected. Cattle and horses bred and maintained on "affected" properties have shown no evidence of any corresponding problem.

(*iii*) *Breed and Sex.*

Although the Merino is the dominant breed within the area there are a number of "affected" properties where other breeds, notably crossbreds, constitute a proportion of the flocks raised. The evidence from these, in particular, indicates that the Merino is very much more susceptible to dystokia and infertility than is the crossbred (Romney Marsh, Border Leicester or English Leicester x Merino). Information regarding pure British breeds is rather limited.

The incidence of prolapse, however, appears to be quite uninfluenced by breed.

With regard to the male, the results of mating observations indicate that the infertility of the ram is unimpaired. Wethers on the other hand not uncommonly exhibit milk secretion and develop an accessory organ ("false bladder") which will be described later.

(*iv*) *Age.*

A survey of records indicates that the Merino maiden four-tooth ewe group (mated at 2½ years) consistently shows the highest incidence of dystokia although the incidence is not confined to any age group.

The infertility may affect breeding ewes of any age. The maiden two-tooth, for ewes are commonly mated at one and a half years in the subterranean clover areas, appears to be the least susceptible age group. For example, on property "R" the two-tooth lambing percentages were 90, 90 and 70 during the years 1943-1945 inclusive whereas the corresponding lambing percentages were 69, 40 and 39. These low percentages are largely the result of infertility although dystokia was contributory.

Prolapse is met with in ewes of any age, but the incidence appears to be much lower in ewes below two years old; cases have been reported in lambs 3-4 months old but the only one we have examined proved to be a prolapse of the vagina only.

(v) Condition.

Sheep bred and maintained on subterranean clover pastures generally carry high bodily condition almost throughout the year and it was widely considered by farmers that high condition, unusually marked in the years 1941-1943, contributed to the incidence of dystokia and infertility. Observations and experimental studies carried out by us, subsequently, have given little evidence in support of this claim.

The possible influence of bodily condition on the incidence of prolapse has not been investigated. Prolapse occurs both in ewes which have bred and ewes which have not bred during the preceding lambing (May-June). The data available is insufficient, however, to indicate whether breeding does or does not affect the subsequent incidence of that condition.

5.—SYMPTOMS.

This account of the clinical features or symptoms of dystokia, infertility and prolapse is based on the examination of large numbers of affected animals observed during the period 1943 to 1945 in the course of investigations on affected properties, and from observations on experimental groups, some mated with raddled rams, maintained on affected properties or at State Research Stations (Beverley and Merredin).

(i) Dystokia.

Dystokia is here used in a restricted sense to describe a specific condition which differs, clinically, from the familiar type not uncommonly affecting a small percentage of ewes in the flocks and which is usually due to abnormal size or position of the lamb. The condition here considered is a maternal dystokia characterised by ephemeral labour and failure of the ewe to show concern or discomfort prior to the advent of complications resulting from the death of the foetus. Towards the end of the in-lamb period the appearances of the body and a degree of udder development indicate that the ewe is pregnant and due to lamb. At term, however, there is only a feeble and brief period of labour, frequently when the ewe is in the standing position. This results only in rupture of the foetal membranes (water bag) and escape of the foetal fluids. Following this almost momentary attempt at lambing no further effort is apparent, and the ewe unconcernedly rejoins the flock.

Quite commonly there is no external evidence of the foetus at this stage and very careful and prolonged observations are necessary to find these early cases in the paddock; delivery is then accomplished relatively easily although the lamb, in most instances, is already dead.

In general the ewe is not noticed to be in trouble till some days later when the feet or portion of the head of a dead lamb is noticed protruding from the vulva. Other signs are, humped attitude, occasional abdominal straining, the presence of a functioning udder greatly distended with milk and, not uncommonly, attempts to foster young lambs. At this stage the foetus is generally more or less decomposed, the uterus is dry, the vulva-vaginal canal ("the passage") has contracted and delivery is accomplished only with difficulty; an inversion of the uterus, not related to the manifestation "prolapse" which occurs in the spring months, is a common sequel.

Ewes affected with dystokia, are frequently not noted till some weeks or months later when the flock is brought in and handled. The signs then noted are putrid vaginal discharge, general ill health, abnormal posture and occasional

straining. In some cases the only evidence may be the palpation of a mummified foetus through the abdomen; the actual discharge of foetal remains through the abdominal wall has been reported.

This is the usual picture in the flock. Less commonly a large proportion of ewes affected are able to deliver the full term foetus although the lamb is born dead. The birth of a high percentage of dead lambs is sometimes a feature during the first year of occurrence of dystokia in the flock. It is considered that both manifestations described merely represent different degrees of a maternal dystokia resulting from uterine inertia and leading to death of the full term foetus because of delayed parturition or non-delivery.

(*ii*) *Prolapse.*

The prolapse referred to is a prolapse of the inverted uterus proceeding to a more or less complete inversion of the organ. The earliest stage, revealed by careful observation of the flock, is the ewe lying down bleating and straining as though attempting to lamb, this being followed by the early appearance of prolapsed uterus and cessation of straining. The affected animals, however, are rarely noticed until the prolapse is obvious externally and we personally have seen very few cases at an earlier stage. After the prolapse is apparent externally the condition develops progressively until, within a week or two, the body of the uterus is completely, and the horns are partially, inverted. The prolapse projects from the body as a swollen tube up to ten inches long by three inches in diameter terminating in partially inverted horns. The exposed lining is at first highly inflamed and red but later becomes grey, dead and eroded. The initial swelling and great enlargement of the organ subsides.

Affected animals are usually slaughtered when found. If not, they may survive for months or die from infection, toxaemia or from the effects of rupture of the prolapsed uterus. Attempts at replacement of the prolapsed organ and its fixation by various methods adopted by sheep owners are not generally successful. This is to be expected in view of the great stretching and weakening of the supporting ligaments.

Spontaneous "recovery" is known to occur but it is doubtful if the "recovery" is permanent; recurrences have been seen some months later in such cases and it is suspected that they are not uncommon. It is difficult to understand how a well developed prolapse can reduce spontaneously but we have definite evidence that this does happen.

(*iii*) *Infertility.*

The infertility has no characteristic clinical features. Observations carried out on experimental sheep from "affected" properties indicated that there was no failure of oestrum (heat). Infertile ewes came in more or less regularly to service but did not get in lamb. The infertility appeared to be due to failure to conceive. Ten of the experimental ewes were killed within a few days of the last of a number of apparently infertile services. None showed any evidence of conception having occurred. From four killed 4-6 days after service unfertilized ova (eggs) were obtained from the tubes or uterus. On present evidence it appears therefore that the infertility results from failure of fertilization of the ovum. It is not unreasonable to assume that this is due to the unfavourable influence on sperm activity of a cystic endometrium, a constant abnormality in infertile ewes examined so far.

6.—PATHOLOGY.

A more complete account of the pathology, i.e. the changes in the organs revealed by naked eye and microscopic examination, is given in another publication by Bennetts, Underwood and Shier (1946)*.

A summary of this information is adequate for the present purpose.

In order to study any abnormalities present in ewes in affected flocks a detailed examination was made of the following animals slaughtered for the purpose during the period 1943 to 1945:—Fourteen cases of infertility, 15 cases of dystokia, 23 cases of prolapse and two groups each of 50 apparently healthy young ewes selected at random from flocks on two properties where the breeding problem was being studied. The cases of infertility, dystokia and prolapse were obtained from several different properties.

A detailed examination of the genital and other organs revealed no significant or constant abnormalities other than the frequent occurrence throughout the series of a cystic endometrium. In some cases the uterus contained a colourless fluid as much as one ounce being seen (hydrops uteri).

The cystic condition varies considerably in degree. In some cases, particularly in known infertile ewes, on opening the uterus large and numerous cysts are seen just below the inner lining of the organ. These have the appearance of raised blisters containing fluid. A cut through the wall of the organ shows that it is honey-combed with these cavities containing fluid. These cysts may be up to three-fifths of an inch in diameter. More commonly, however, the cysts are quite small (1/10th in. to 1/25th in. in diameter) and only a few may be visible so that the abnormality is missed unless a careful examination is made. In other cases the abnormal condition of the uterus is revealed only by microscopic examination. The results of this study indicate that cystic endometrium is common in flocks depastured on affected properties; that ewes may be affected at an early age (14 months) and that the numbers affected and the severity in the individual increases with age.

Cystic endometrium is well known in women and has been extensively investigated both in humans and experimental animals. The occurrence of the same abnormality in ewes in affected flocks is therefore a valuable indicator of the possible nature of the causal factor or factors operating in the breeding problem under investigation.

In this connection valuable supporting evidence is provided by the observation that udder development and milk secretion in both maiden and unbred ewes commonly occurs in affected flocks depastured on early-subterranean clover. This phenomenon is noted during the spring and early summer months when udder development may be marked and milk secretion copious, particularly in favourable seasons (e.g. 1942 and 1943).

It may be stated here that a bacteriological examination of ewes affected with infertility, dystokia and prolapse has given no evidence that the breeding problem is of infectious origin.

7.—MILK PRODUCTION AND "FALSE BLADDER" IN WETHERS.

The above conditions which occur on early-subterranean clover properties are important not so much from economic considerations, but because the nature of the changes involved throws further light on the probable cause of the associated breeding problem of ewes.

*Bennetts, H. W., Underwood, E. J., and Shier, F. L., (1946).—Aust. Vet. J., in press.

For this reason a brief description of these extraordinary manifestations is included. Their significance will be discussed later.

(*i*) *Lactation in Wethers.*

This has been reported from a number of early subterranean clover properties, particularly in the spring of 1942 and 1943 when "the shearers were squirting milk on the board." It was stated that on one property, in 1942, some 300 wethers, about eight per cent. of the total carried, showed evidence of lactation. The owner estimated that in some cases there was about half an ounce of secretion.

We had no opportunity of investigating the phenomenon until October, 1945, when we examined a number of subjects on several properties. There is a more or less marked development of the teats with secretion into a closed space bounded by the teat wall and above by a capsule which covers the base of the teat; there is no udder development, but the milk is secreted by tissue lining the teat wall. There may be as much as half an ounce of secretion contained in each teat. It resembles ewe's milk in appearance and has a similar chemical constitution.

The degree of the teat development may correspond to that of a ewe in full lactation, e.g., in one case the teats were 2½ in. long and 2 in. in diameter at the base.

(*ii*) *"False Bladder."*

This extraordinary phenomenon consists essentially of the almost incredible development of a new accessory organ in the form of a large sac which communicates with the urethra (the tube leading from the bladder to the penis) and which thus becomes filled with urine.

This sac, up to 6 in. in diameter, may almost completely fill the pelvic cavity and is visible externally as a large fluctuating swelling which may bulge out the whole region of the crutch below the anus. In some cases this sac may rupture through the skin and, particularly when the normal passage is blocked as a result of stones or an inflammatory process, the urine may be voided from this opening in the lower portion of the crutch.

The condition described becomes apparent during the spring when the wethers affected may be recognised by reason of loss of condition and the presence of the swelling mentioned. They frequently give evidence of being in pain. Wethers do not usually survive for many weeks after the affection is first recognisable; they lose condition rapidly and die as a result of toxaemia or infection.

Reports indicate that the condition described is not uncommon on early-subterranean clover properties and that it is restricted to them. The reported occurrence of clinically recognisable cases is low, the highest reported being two per cent. on one property.

The significant feature of this condition from a scientific point of view, is the structure of the wall of the sac. The nature of the membrane lining is identical with that of the female vagina. This, as well as other highly significant (metaplastic) microscopic changes in the male sex organs points to the influence of some "feminising" agent, the probable nature of which will be discussed later.

8.—DISCUSSION.

The evidence available to the present time indicates that the breeding problem with its three manifestations, infertility, dystokia and prolapse, is of nutritional origin and that a diet of "affected" early-subterranean clover is the principal causal factor.

The abnormalities found in sheep in affected flocks, i.e., a cystic condition of the uterus in ewes, the development of "feminine" changes in the male sex organs and the secretion of milk by unbred ewes and by wethers, are identical in nature with changes known to be produced in humans and various species of experimental animals by an excess of a female sex hormone (oestrogen). This hormone is a substance produced naturally in the entire animal and is one of the important factors controlling the whole reproductive process in the female.

It has been shown further that the cystic condition of the uterus can be produced regularly in guinea pigs fed for some weeks on a diet of "affected" subterranean clover.

It is most probable therefore that the clover contains some substance which causes animals to produce an excess of oestrogen or contains substances which when eaten exert a similar effect to oestrogen in the animal body.

A series of experiments with guinea pigs designed to elucidate the nature of the potent substance or substances present in "affected" subterranean clover is already proceeding. At the same time an endeavour is being made to assess the potency in the plant at different stages of growth.

It remains to be demonstrated also whether the potent substance (or substances) whose presence is deduced from the effects produced, is innate to the Dwalganup strain or is an abnormal product (or products) developed in this and possibly other plants as a result of unfavourable environmental factors, e.g., mineral deficiency or excess in the soil.

Experiments are being carried out also to determine whether sheep can be bred satisfactorily on "affected" properties when the clover pasture is balanced by other herbage, notably oats and wimmera rye grass.

Another series of experiments being carried out with sheep, although not yet complete, has shown definitely that the effects of grazing on "affected" clover persist for at least several months; sheep may remain infertile or may develop dystokia long after they have been removed from clover pastures. This finding is of obvious practical significance.

The results of these series of experiments and of others not referred to, will be published when available.

9.—SUMMARY.

(i) A description is given of a very serious breeding problem of sheep on early-subterranean clover pastures in parts of Western Australia. There are three manifestations of the disease in the ewe: infertility, resulting apparently from failure to conceive; dystokia or difficult birth involving the death of the full-term foetus; and prolapse of uterus occurring generally some months after lambing or even in unbred females.

(ii) Rams remain fertile and apparently quite unaffected, but wethers may show the extraordinary phenomenon of marked teat development and milk secretion. In some cases they develop a swelling below the anus which on post-mortem is found to be due to the presence in the body cavity of a large sac containing urine. This actually has a structure similar to the female vagina.

(iii) Merino ewes are more susceptible to the infertility than cross-breds and on most properties show a higher incidence of dystokia. Merinos and crossbreds appear to be equally susceptible to prolapse. There is little evidence regarding the susceptibility of the British breeds.

(iv) Ewes transferred from "sound" to "affected" areas remain fertile and free from dystokia or prolapse for at least one lambing season. Present evidence suggests that their fertility falls in the second season on "affected" country. Ewes reared on "affected" properties remain infertile or susceptible to dystokia even after transference for at least one season to sound country.

(v) Infertile ewes come into season and take the ram normally but do not conceive. This failure to conceive is believed to be due to a cystic condition of the lining of the uterus (cystic endometrium) which has been found to be constantly present in such ewes.

(vi) The breeding troubles are not due to infection but are of nutritional origin. Strong evidence has been obtained that the "affected" clover contains some chemical substance or substances with an effect similar to that of excess of the female sex hormone (oestrogen).

(vii) Cystic endometrium has been produced experimentally in guinea pigs fed "affected" subterranean clover. Such clover has been preserved in a potent condition and work designed to elucidate the nature of the toxic principle is proceeding. The ability to use guinea pigs will be of enormous advantage in this work.

10.—RECOMMENDATIONS.

It is evident from the summary that considerable knowledge of the problem has already been obtained, but that several years of intensive research will be necessary before this is complete and control methods developed. However, a number of practical suggestions can be made to farmers which, if adopted, should help them to keep the total productivity of affected properties as near their normal level as possible.

(i) Once a low level of fertility has developed in a flock there is nothing the farmer can do to render the barren ewes fertile. It is useless to continue breeding with such ewes. The small percentage of lambs obtained would not compensate for possible losses from dystokia.

(ii) The fat stock market offers a reasonable outlet for ewes of this type which can be expected to be fat in late summer and autumn. Alternatively ewes of good quality could be maintained as pure wool producers. A policy of fattening and wool production with purchased wethers would be satisfactory, but its general adoption is limited by the supply of wethers.

(iii) A breeding programme based on the regular purchase of ewes from "sound" areas could also be adopted. Such ewes have been shown to lamb normally for at least one season after transfer to affected country. For many farmers this would involve a considerable loss of "quality" in their flock, but is the only way in which a breeding programme could be maintained. Aged ewes would obviously be the most suitable for this policy as they are by far the cheapest and would not have the same time to become infertile as younger ewes. If the rams used were of the long wool British breeds such a breeding policy would be very satisfactory from the financial aspect in view of the very strorg demand by fat lamb growers for long wool crossbred ewes.

(iv) Fat lamb production for export based on Corriedale or crossbred ewes cannot be recommended with confidence for affected properties (even if the ewes were available) because a number of flocks of these breeds have already given evidence of the breeding troubles and others may become affected in the course of time.

(v) Baby beef production, based on such breeds as the Aberdeen-Angus or Red Poll could be developed with distinct advantage as one of the activities on many affected farms at present carrying only sheep. At the present time this is a very profitable form of production.

(vi) Increased production of cereal crops and the introduction of Wimmera rye grass can also be recommended for many properties where the subterranean clover development has resulted in a marked increase in soil fertility. There is no definite evidence that this will reduce the incidence of the breeding troubles, but it will certainly not increase them, and will result in a more balanced grazing and increased productivity from the farm as a whole.

11.—ACKNOWLEDGMENT.

We are indebted to Dr. L. B. Bull and Mr. A. J. Vasey of the Council for Scientific and Industrial Research, for helpful advice, to the Australian Wool Board, for generous financial assistance, and to many sheep owners throughout the affected area for their ready co-operation.

The Cystic Tapeworms (Bladder-worms) of Sheep.

C. R. TOOP, Assistant Chief Veterinary Surgeon.

WHEN sheep are examined at postmortem, bladder-like structures or cysts containing a clear watery fluid may frequently be observed in the body cavity and in various tissues and organs. These are tapeworm cysts and represent larval or immature forms of tapeworms, the adult form of which is found in the intestine of the dog and other closely allied animals.

Three kinds of tapeworm cysts are found in sheep in Western Australia. Two of these are Cysticerci in which the cyst contains a single tapeworm head. The third is the Echinococcus or hydatid cyst which contains numerous tapeworm heads and frequently grows to a large size. These cysts rarely affect the general health of the sheep and their presence is detected only when the animal is subjected to postmortem examination. Two of them, however, are of considerable importance. Cysticercus ovis is responsible for the condition known as "sheep measles" causing the rejection of lamb and sometimes mutton carcases intended for export. The Echinococcus or hydatid cyst not only occurs in sheep but affects other animals and man, constituting a danger to human health.

The sheep becomes infected by swallowing tapeworm eggs passed out by infected dogs which contaminate the pastures. The dog in turn becomes infected from the consumption of raw offal containing tapeworm cysts. For the control of the parasite it is necessary to break this cycle firstly by the treatment of dogs for the removal of the adult tapeworms and secondly by the adoption of precautions which will prevent the dog from obtaining access to raw offal.

Cysticercusovis—"Sheep Measles."

Cysticercus ovis occurs principally in the heart muscle and diaphragm where the cysts may be present in large numbers. The cysts may also be observed in various locations of the muscular system and in the tongue as well as in the walls of the oesophagus (gullet) and stomach. The cysts are oval in outline and measure about a third of an inch in length by a sixth of an inch in breadth, the

tapeworm head being situated about midway between the ends. C. ovis occurs predominantly in lambs. The cysts undergo rapid degeneration and are much less frequently observed in adult sheep. From the appearance of the tissues in which the cysts are located, the condition is sometimes referred to as "sheep measles."

C. ovis is of quite considerable importance to the export lamb industry. Upon examination, carcases showing evidence of infection, are rejected as unsuitable for export. Such carcases are sold on the local market usually at a reduced figure and with consequent loss to the producer. The incidence of C. ovis infection in lambs varies considerably from season to season. Records which have been kept at the Meat Export Works over a number of years, indicate the average annual rejections from this cause to be in the vicinity of .25 per cent.

It is necessary to mention that the parasite is not transmissable to man and that the presence of cysts in lamb carcases is of no importance in relation to human health.

Cysticercus ovis in the heart muscle of a sheep. (After Drabble.)

Life History.

The adult tapeworm is known as Taenia ovis. It occurs in the intestine of the dog and allied species such as the fox and dingo, and varies in length from about 18 inches to five feet. Like other tapeworms the parasite is flat and ribbon-like and consists of a head and neck and a chain of segments. The head is small and provided with suckers and hooks which enable the parasite to attach itself to the lining membrane of the bowel. The segments are rectangular and increase in size from the head backwards. As the segments mature or ripen, they become detached and are replaced by new segments which form behind the neck. The ripe segments contain tapeworm eggs which are passed out in the droppings and contaminate the pastures over which they may be distributed by the action of wind and rain. The tapeworm eggs are swallowed by sheep while grazing and upon reaching the intestine, the shell is digested and a minute embryo armed with six hooks is liberated. The embryo bores through the bowel wall and gains access

to the blood vessels, being carried to the liver and then to the heart. From this point it passes into the general circulation and is carried to locations such as the heart muscle and diaphragm, where it is detected at postmortem. Here the embryo continues to grow developing into a mature tapeworm cyst after an interval of two to three months. The dog becomes infected by eating raw offal, e.g., the heart, containing tapeworm cysts. Upon reaching the intestine of the dog, the bladder is digested setting free the tapeworm head which becomes attached to the bowel wall. After an interval of about two months, a chain of segments is developed and eggs commence to be voided in the droppings. This completes the life cycle of the parasite. The life histories of Cysticercus tenuicollis and Echinococcus granulosus are similar.

Taenia ovis.—This tapeworm occurs in the intestine of the dog, fox and allied species. The larval form is known as Cysticercus ovis and is found in the heart muscle and diaphragm of the sheep.

[U.S. Dept. of Agriculture.]

Control.

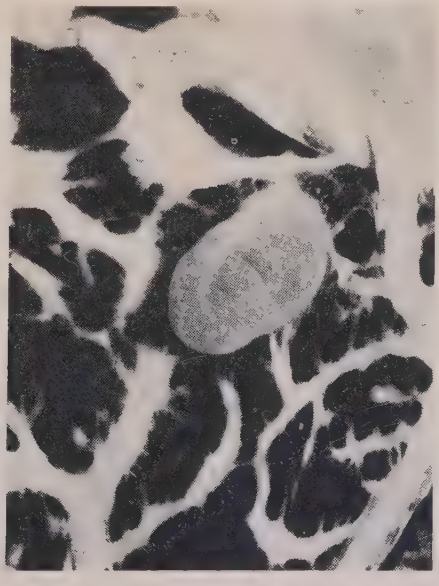
Since sheep become infected by the ingestion of tapeworm eggs voided by dogs, control measures should be directed towards the prevention of infection of dogs together with treatment for the removal of the adult tapeworms.

In order to prevent infection, dogs should never be fed or allowed access to raw offal. Such material may, however, safely be used after boiling for 10 minutes which will destroy the tapeworm cysts. In addition, all dogs on sheep-raising properties should be regularly treated with drugs for the removal of tapeworms. Arecoline hydrobromide is highly effective for this purpose. The drug may be procured in the form of ½ grain tablets. This is the dose for a sheep dog of average size and it may be given either in tablet form or in solution, after the tablet has been dissolved in a fluid ounce of water. In smaller dogs such as terriers, the dose should be reduced to ¼ grain, while in the case of kangaroo dogs and animals of similar size, a dose of one grain may be administered. Treatment should be repeated at intervals of six months.

Since the fox, dingo and feral dog (domesticated dog gone wild), may also harbour the tapeworm, the control measures outlined above must be advocated with a good deal of reservation. A survey carried out in Victoria some years ago showed that foxes may harbour the adult tapeworms in considerable numbers. Although this survey was confined to a limited number of animals, it indicated the fox to be a natural host of the tapeworm and that foxes may be infected to a much greater extent than are dogs. Support is lent to this view by the fact that the fox frequently kills young lambs, devouring the tongue and muscular tissues. In view of this evidence it has been suggested that the fox may be a much more important factor in the dissemination of C. ovis infection in sheep than is the dog. It is possible in some localities that the dingo and wild dog may play a similar role. If this is the case, the control of the parasite is no longer a practical proceedure and will be effective only to the extent to which the destruction of foxes and similar vermin is possible.

Cysticercus tenuicollis—the thin-necked bladder worm.

Cysticercus tenuicollis occurs principally in the abdominal cavity and is commonly observed at abattoirs, and in sheep killed for ration purposes. The cyst consists of a thin-walled bladder one to two inches in diameter containing clear watery fluid and may be observed hanging from the omentum and mesenteries (abdominal membranes), when the body cavity is opened. The tapeworm head appears as a white opaque spot in the wall of the cyst. Usually not more than three or four cysts are present in an affected sheep. Occasionally, however, as the result of a gross infestation, hundreds of cysts are found scattered throughout the abdominal cavity and at times partially embedded in the liver tissue. In addition to the sheep, C. tenuicollis may be found in cattle, pigs and goats. The parasite is of no importance to human health but is sometimes confused with the Echinococcus or true hydatid cysts, particularly when embedded in the liver.



Cysticercus tenuicollis attached to the omentum of a sheep. (After Clunies Ross and Gardner.)

The adult tapeworm is known as Taenia hydatigena. It is found in the small intestine of the dog where it may attain a length of 16 feet. The life history of the parasite is similar to that described for T. ovis. Upon reaching the liver the embryo leaves the blood vessels and penetrates the liver tissues in which it wanders until it reaches the surface of that organ. It then ruptures the surface of the liver and penetrates the abdominal cavity attaching itself to the abdominal membranes. Here further development takes place finally resulting in the development of the typical bladder-like cyst.

Despite the damage to the liver tissues caused by the migrating embryos, affected sheep suffer no ill effects, the presence of the infection only becoming apparent during examination at the time of slaughter. Since the parasite is of little economic importance and of no importance in relation to human health, the application of measures for its control are rarely warranted. Should such measures be contemplated they would follow the lines described for the control of C. ovis.

Echinococcus granulosis—the Hydatid Cyst.

The Echinococcus or hydatid cyst is found in the lungs and liver but may occasionally occur in other tissues and organs. These cysts vary in size from a quarter of an inch to six inches or more in diameter. The cyst is enclosed in a firm fibrous capsule laid down by the body tissues and is lined by a delicate

Hydatid cysts (Echinococcus granulosus) in liver of sheep.
[U.S. Dept. of Agriculture.]

membrane from which tapeworm heads grow. It is filled with clear watery fluid and contains minute objects resembling grains of sand attached to the cyst wall or floating in the fluid. These are brood capsules each of which contains a number of tapeworm heads. In addition to the sheep hydatid cysts occur in cattle, pigs, other animals and man. In the sheep, which is the natural host of the parasite, the majority of the cysts are fertile, whereas in cattle the cysts are usually sterile containing no living tapeworm heads. About 20 per cent. of the cysts occurring in pigs are also sterile.

The parasite has a wide distribution and is especially prevalent in sheep-raising countries where hydatid cysts commonly occur both in animals and man. In certain areas of Victoria, and New South Wales from 20 to 30 per cent. of sheep and cattle examined have been found to be infected, while in New Zealand an even higher incidence than this has been recorded. The incidence of infection is much lower in Western Australia. At the Midland Junction abattoirs where all animals are subjected to postmortem inspection at the time of slaughter, the records for the years 1943 and 1944 show that less than two per cent. of the sheep examined were infected with hydatid cysts. The figures for cattle and pigs were correspondingly low, being less than .5 per cent. in the former and less than .25 per cent. in the latter.

During the course of meat inspection at abattoirs, organs such as lungs and livers containing hydatid cysts are condemned and subsequently destroyed. Since the cysts do not usually occur elsewhere in the body, condemnation of the carcase is rarely necessary. Infected sheep appear to suffer no ill effects from the presence of the cysts. Even massive infections causing extensive damage to the liver tissues are usually only detected during inspection at the abattoirs.

Life History.

The adult tapeworm occurs in the intestine of the dog and allied species such as the dingo and fox. Unlike the other tapeworms described, it is extremely small rarely exceeding a quarter of an inch in length and containing only two or three segments. On account of its small size and the fact that dogs rarely show any symptoms of the infection, the presence of the parasites is generally overlooked.

The life history of Echinococcus granulosus is similar to that described for T. ovis. Tapeworm eggs voided by infected dogs are swallowed by sheep while grazing and upon reaching the intestine the shell is digested and an embyro is liberated. The embyro penetrates the bowel wall gaining access to the blood vessels by which means it is carried to the liver or lungs where it becomes arrested. Here the embyro continues to grow developing after a period of several months into an Echinococcus or hydatid cyst. Dogs become infected by the consumption of raw offal containing the cysts.

Infection of Man.

The importance of the parasite lies chiefly in its relation to human health; tapeworm cysts located in the liver, less frequently in the lungs and sometimes in the bones causing hydatid disease, a serious and sometimes fatal condition in man. In Western Australia hydatids is not a notifiable disease under the Health Act and consequently the incidence of infection in human beings is unknown. Statistics, however, show that a small number of deaths have occurred annually from the condition.

As in the case of the sheep and other animals, infection in man results from ingestion of tapeworm eggs passed out by infected dogs. The risk of infection is greatest from contact with dogs kept at slaughter houses or on farms and stations where they are able to gain access to raw offal. In cities and large towns where a system of meat inspection exists resulting in the condemnation and destruction of diseased organs, the risks of infection are remote.

The principal risk lies in the handling and fondling of infected dogs. Dogs which are kept on the chain or confined in yards, pass their droppings in the vicinity of the kennels. These eventually disintegrate becoming mixed with the dust. When the dog lies down its coat becomes contaminated by dust containing tapeworm eggs. The risk of infection from the handling of dogs kept under such conditions is apparent, particularly when the precaution of washing the hands is overlooked. The danger is greatest in children who have no knowledge of hygiene. The majority of infections are believed to occur during childhood but these often do not become apparent until adult life.

Other methods of infection include the consumption of raw vegetables such as lettuce contaminated by tapeworm eggs derived from the excretions of dogs, or of water similarly contaminated, but these are considered to be of minor importance.

Prevention of Infection.

Since hydatid disease in man results from the ingestion of tapeworm eggs voided by infected dogs, particular attention should be directed towards the prevention of infection in those animals. Raw offal such as livers, lungs and hearts should never be fed to dogs and provision should be made for the sterilisation of such material by boiling. Boiling for 10 minutes will destroy the parasites. In addition dogs should be regularly treated with arecoline hydrobromide for the removal of tapeworms. Dogs while under treatment, should be chained until purgation has ceased, when the droppings which may contain large numbers of ripe segments and eggs, should be collected and burned. Similarly, dog yards and kennels should be maintained in a clean condition, droppings and bedding being regularly collected and destroyed by burning.

The precaution of washing the hands after handling dogs should never be neglected and this is particularly necessary before partaking of meals. Children require particular supervision in this connection. Young children should not be allowed to play with dogs or in the vicinity of their kennels. Dogs should be excluded from rooms in which food is being prepared or stored. Raw vegetables such as lettuce should be thoroughly washed in running water before use and dogs should be excluded from vegetable gardens. If the drinking water is drawn from a doubtful source it should be boiled before use.

These precautions should be practised in country districts but they should not be necessary in cities and large towns where an efficient system of meat inspection exists.

[*Published by Angus and Robertson, and obtainable at all booksellers for 15s.*]

"Principles and Methods of Animal Breeding."

By Dr. R. B. Kelley.

SOME ten years ago the United States Department of Agriculture, inspired, no doubt, by the then Secretary for Agriculture, Henry Wallace, published two year-books which were devoted to a survey of animal and plant breeding. The theme of the review devoted to livestock was "Animal Breeding at the Cross-roads." As an epilogue, it may be remarked that during the period 1935-42 egg production per bird in the United States increased more than in the previous 25 years.

The alternatives which the animal breeder has encountered are whether to continue down the broad highway followed in the past, or to deviate in accordance with the results of genetic research. Dr. Kelley presents a closely reasoned and amply documented case for basic changes in outlook, and it is pleasing to find his views being made available by an Australian publisher in a very handsome but moderately priced book.

Dr. Kelley begins by reviewing the work of early English animal breeders, such a Bakewell, and the creation of three famous breeds of livestock. He then traces the methods whereby the modern knowledge of genetic principles was established through the co-ordination of results obtained in widely differing fields.

The closing chapters contain a constructive survey of modern animal breeding methods and those current in Australia. Dr. Kelley is in the fortunate position of being able to draw on first hand knowledge of animal research in U.S.A. and U.S.S.R.

The chapter, Modern Animal Breeding, contains information on the most recent developments in U.S.A. and prewar Denmark, which all emphasise the importance of progeny-testing. The review of Animal Breeding in Australia is very frank, but the criticism is constructive and the author endeavours to show that better methods are not only necessary but within the capacity of the industry.

Before proceeding to a detailed discussion of progeny-testing in fine wool sheep, Dr. Kelley devotes a chapter to artificial insemination which is an important adjunct to improved breeding methods. The fine wool sheep is too important in the Australian economy for its improvement to be anything but the major problem of the industry.

The concluding chapter on Current Research refers, in the main, to investigations of animal husbandry rather than genetics. Reference is made to the local work of Shier and Underwood at the Avondale Research Station on the effect of "flushing" but, no doubt, considerations of space precluded mention of their data on the onset of the breeding season. The factors genetic and environmental which cause ewes to come into oestrus after a non-breeding season are not well established, but Shier and Underwood have shown that there is great uniformity in the date of onset. Dr. Kelley directs attention also to the work being carried out at the University Institute of Agriculture on the relationship of protein intake and wool growth.

Dr. Kelley's book is the first comprehensive Australian publication on animal breeding, and it will be a valuable aid to enlightened animal owners who find themselves at the cross-roads, and to agricultural extension workers. It is not a textbook on genetics and the average reader will benefit from previous reading on heredity as such. Much of the theory of animal genetics rests on rather involved mathematical formula but Dr. Kelley makes the application of modern methods a straight forward, highly interesting and profitable procedure.

A.J.M.

The Resazurin Test for the Determination of Quality in Milk—A Preliminary Trial.

By K. Needham, Agricultural Adviser.

SYNOPSIS.

The mechanism of the Resazurin test is explained; the method of performing it is outlined, and the advantages of the test compared with those of the Methylene Blue are listed. A brief account of the tests performed at a cheese factory is given.

INTRODUCTION.

THERE have been a number of tests described for the determination of quality in milk in which the use of a dye is employed. One of the most familiar of these, and which is in common use in the dairy industry in this State, is the Methylene Blue Reductase test.

The time required for the Methylene Blue to change from the original blue to white in the sample under observation is recorded and this time is taken as an indication of the quality of the milk in respect to the activity of the bacterial population. A minimum time is prescribed under which the milk must not reduce the Methylene Blue if it is to measure up to the prescribed standards. These times vary but the minimum is usually three hours.

In that section of the dairy industry dealing with whole milk for human consumption, or for cheese milk, there has always been need for some rapid analysis which will give a fairly accurate indication of the bacterial quality of the milk in a short time.

THE MECHANISM OF THE TEST.

The Resazurin test has been developed recently and more nearly approximates the above requirements than the Methylene Blue examination. The principles involved in all dye examinations are based on the fact that the majority of the bacteria during their essential life process have a reducing effect on certain dye stuffs with a resultant change in colour. The degree and rapidity of the reduction varies both with the type and number of organisms present.

The dye Resazurin undergoes two main chemical reactions during its reduction. The first is an irreversible change from blue Resazurin to pink Resorufin and the second is a reversible change from pink Resorufin to colourless Dihydro Resorufin. The two stages cover colours ranging from the initial blue through lilac, mauve, pink and finally to white.

All things being equal it has been found that the colour changes occur in most instances far more rapidly with the dye Resazurin than with Methylene Blue. The advantages of this quicker change are obvious, both from the point of view of the factory and the laboratory. In the case of the factory economy in time of observation is effected and, in the laboratory, time and materials are saved when compared with the more expensive and more protracted plating method.

METHOD OF PERFORMING THE TEST.

The method of performing the Resazurin test is very similar to that used with Methylene Blue. Ten mls. of the sample to be examined are measured into a sterile test tube and one ml. of a 0·005 per cent. solution of Resazurin is added.

The temperature of incubation, 37·5° C., is slightly higher than that used with Methylene Blue (37° C.). The practical difference between the two tests is that, whereas with Methylene Blue examinations observations may be necessary for up to eight hours or even more, with Resazurin the same information can be obtained in one hour. With Resazurin the colour developed at one hour is noted and an indication of quality is obtained. Sterility of technique is observed throughout.

There has been a ten minute Resazurin test suggested, but this does not permit of the finer grading of the milk which is obtained by means of the longer incubation period of one hour.

ADVANTAGES CLAIMED FOR RESAZURIN TEST.

The following advantages have been claimed for the Resazurin test as compared with the Methylene blue test for milk control work.*

1. *Simplicity.*—Only one reading, for example, at one hour is required compared with from six to 12 readings with the Methylene Blue if it extends up to six hours.

2. *Sensitivity to weakly reducing organisms.*—A milk rich in only weakly reducing organisms usually affects Resazurin but may fail to reduce Methylene Blue for many hours.

3. *Sensitivity to cell content (Mastitis).*—A high count of cells whether due to mastitis, colostrum, or late lactation milk, is usually associated with other abnormalities and is disadvantageous for many reasons. Resazurin, but not Methylene Blue, is sensitive to high cell counts in aged milks.

4. *Relation to initial flora.*—In a short time test the result is more likely to bear a closer relation to the initial flora than in a longer test.

5. *Possible contamination in sampling and testing.*—This will naturally be of less significance in a short test.

6. *"Methylene Blue test."*—By prolonging the test to complete reduction it becomes in effect a "Methylene Blue test" of slightly longer time.

LOCAL TRIALS.

Although the Resazurin test has been recognised by the British Ministry of Agriculture and Fisheries as a routine examination, before advocating the use of the test in this State it was considered advisable to carry out some preliminary trials with a view to ascertaining its suitability for application to the industry in Western Australia. This was necessary because of different climatic conditions obtaining and also because of the different set-up in factory routine and facilities for laboratory examination.

It is the practice of the Department of Agriculture to conduct clean milk competitions, and in the course of these competitions, one of the tests used is the Methylene Blue Reductase test. With the co-operation of one of these cheese factories it was possible to arrange to carry out a series of Resazurin trials on duplicate samples which had been subjected to the Methylene Blue examination. Two series of trials were conducted which included 141 samples.

Morning milks were sampled on the receiving platform and duplicate samples taken for Methylene Blue and Resazurin tests. Within an hour of sampling, the Resazurin dye had been added and the tubes were incubated in a water bath, maintained as nearly as possible under factory conditions, to the prescribed 37·5° C.

*Reprint of the article by J. G. Davis of the National Institute for Reearch in Dairying, in Discovery, March, 1943.

Immediately following the introduction of the Resazurin dye, the sample remaining in the sample bottle was smeared for examination later on by means of the microscope.

In Great Britain a series of standard colours have been prepared and these are used preferably in daylight, but, if necessary, with artificial daylight, for comparison with the colours developed in the samples.

By this means the persons performing the test are comparing colours under the same conditions and the element of personal error is largely eliminated. Unfortunately no such colour discs were available at the time of these examinations and it was necessary to confine recordings to the colours observed by the worker using as nearly as possible the same conditions for each sample. Although this method would be entirely unsatisfactory for the general use of the test at different factories it was suitable for the purpose of this preliminary investigation.

In respect to the 141 samples examined, it was possible with Resazurin to obtain information on the bacterial activity of the samples in one hour, compared with up to six hours and longer, in the case of the duplicate samples subjected to Methylene Blue.

In many samples the Methylene Blue was unchanged at six hours whereas the corresponding sample using Resazurin dye showed a considerable reduction, sometimes even to the white stage at one hour. In a few isolated cases the reverse was observed—slight reduction of Resazurin and considerable reduction of Methylene Blue.

The claim that the Resazurin test is more sensitive to the presence of cells was not fully borne out in the trials. In some instances this was found to be the case while other samples, apparently of high quality on the basis of colour, later showed a very high cell content on direct microscopic examination, and, in one instance, a condition typical of contagious streptococcic mastitis was present. The necessity for regular microscopic checks following dye tests is obvious. It is possible, however, that the lack of sensitivity of the Resazurin to cell content in these examinations was due to the comparative freshness of the milk on examination. In the majority of samples subjected to the Resazurin test in Great Britain, milk is held, according to whether it is a morning or evening sample, up to 24 hours before examination. After a period of holding the activity of the cells is considerably increased compared with the freshly drawn sample.

The technique of performing the test and the various aspects which must be considered in the interpretation of the results have not been discussed in detail in this article. It is hoped when certain equipment now on order is available that it will be possible to conduct further investigations in accordance with the standards prescribed by the British Ministry of Agriculture and Fisheries and to evolve a modified technique which will be suitable for local conditions.

CONCLUSION.

The information obtained so far permits of two main deductions:—

1. That the Resazurin test as claimed is considerably faster than the Methylene Blue test and gives in a shorter time at least the same amount of information and in many cases more.
2. That the Resazurin test like the Methylene Blue test should be followed up at fairly frequent intervals by direct microscopic examination.

ACKNOWLEDGMENT.

The author desires to acknowledge the assistance rendered Mr. N. McKeown, Agricultural Adviser, Mr. V. Weston, Dairy Instructor, and the staff of The South-West Co-operative Dairy Farmers Ltd., Harvey, in the course of these observations.

The Babcock Test for the Estimation of Butterfat in Milk and Cream.

A. H. Hobbs, Dairy Branch.

INTRODUCTION.

FROM time to time inquiries are received from dairy farmers, and others, for details of the technique of the Babcock Test. An endeavour is made in the following article to describe in simple form the various steps in the manipulation of the test while, at the same time, drawing the attention of the beginner to the difficulties which may be encountered, and the necessary precautions to be observed, in order to obtain accurate and satisfactory results.

The Babcock Test was invented by Dr. Babcock, an American scientist, in 1890. It was originally designed for the estimation of the butterfat content of milk, but has since been modified and can be used for milk, cream, skim milk, buttermilk, etc. For practical factory and farm fat determinations, it is now used almost exclusively in the United States of America and Australasia.

It is the test generally used as a basis for payment for milk and cream and, in addition, enables producers to detect unprofitable cows, thus furnishing a valuable guide to herd improvement. It has also aided in the detection of fraud caused by the watering or skimming of milk.

Dr. Babcock based his test on the fact that strong sulphuric acid will break down the "solids not fat" of milk and thus enable the fat to separate out. To effect a speedy and complete separation of the fat the flasks holding the mixture of milk and acid are placed in a centrifugal machine, or so-called "tester," and whirled at high speed. Hot water is then added to bring the liquid fat into the graduated neck of the test flasks and, after repeated whirling, the length of the fat column is measured, showing the percentage of fat contained in the sample tested.

DIRECTIONS FOR TESTING MILK.

Apparatus required:—

- Sample bottles.
- 17.6 c.c. pipette for measuring milk.
- 17.5 c.c. acid measure.
- Sulphuric acid (specific gravity 1.82-1.83).
- Milk test flasks (graduated 0-10).
- Centrifuge (or tester).
- Dividers.
- Dairy thermometer.
- Water bath.

Sampling.

The milk to be tested is first mixed by pouring from one vessel to another two or three times so that the butterfat will be evenly distributed throughout the bulk. The sample is then dipped out immediately and placed in a sample bottle.

Before measuring out the quantity to be tested, the milk in the sample bottle is further mixed by shaking the bottle vigorously. The shaking should not be so violent as to cause undue foaming. The reason for sampling immediately after mixing is that the butterfat is the lightest constituent of the milk and it will commence to rise to the surface within a few minutes if the milk is allowed to stand. Hence the sample taken would not be representative of the bulk.

The measuring pipette, which has a capacity of 17.6 cubic centimetres, is filled with milk by sucking the milk into it until this rises a little above the 17.6 c.c. mark; the forefinger is then quickly placed over the top end of the pipette before the milk runs down. By slightly releasing the pressure of the finger, the milk is now allowed to run down until it reaches the mark. The finger should be moist but not wet, so that the milk may be readily checked by gentle pressure. The point of the pipette is now placed in the neck of the Babcock test flask, and the milk is allowed to flow slowly down the inside of the neck, care being taken that none is lost in the transfer. The last of the milk in the pipette is gently blown into the test flask.

Actually the amount of milk delivered by the pipette is 17.5 cubic centimetres, the difference, .1 c.c., being an allowance made for the small quantity which adheres to the walls.

The temperature of the milk at the time of sampling should be 65-70°F.

The accuracy of the test depends on the fact that the sample taken weighs 18 grams, and 17.5 c.c. of milk at its average specific gravity of 1.032 will be found to weigh this amount.

Adding the Acid.

17.5 c.c. of sulphuric acid, the temperature of which should be 65-70°F., is measured by means of the acid measure. This amount of acid is carefully poured into the test bottle containing the milk. In performing this operation, the test bottle is conveniently held at an angle, so that the acid will run down the wall of the bottle, and not run in a small stream into the centre of the milk. The bottle is slowly rotated during the adding of the acid, thus clearing the neck of adhering milk.

If the acid is poured into the middle of the milk, charring of the fat may occur, and there is also the danger of completely filling the neck with acid, in which case the expansion of air in the bottle may force the acid out on to the operator's hands.

The milk and acid in the test flask should be in two distinct layers. A black band of partially mixed liquid may appear between the layers, but this should be only slight. Such a dark layer often results in an indistinct fat column in the final reading. The appearance of black flocculant matter in or below the fat column renders a correct measurement difficult, if not impossible.

After adding, the acid is carefully mixed with the milk by holding the test bottle by the neck at an angle and giving it a rotary motion. In doing this, care should be taken that the liquid is not shaken into the neck, and when once the mixing has begun, it should be continued until completed. The mixture becomes hot by the action of the acid on the water in the milk and turns a dark chocolate colour. Its temperature will now be about 180°F. Violent mixing may cause charring of the fat, whilst insufficient mixing may produce curd in the fat column.

Note.—Sulphuric acid has a great affinity for water and will weaken, through the absorption of moisture from the atmosphere, if not kept in air-tight containers. It is very corrosive, hence stoppers for bottles should be of glass, earthenware, or rubber. It should be handled with care and, if spilt on the skin, should be washed off immediately with plenty of cold water. If spilt on the clothes, they should be washed as above and then treated with dilute ammonia solution.

Whirling the Tests.

The test flasks containing the mixture of acid and milk are placed in the centrifuge immediately mixing is completed, care being taken that they are placed in such a position that the machine is balanced correctly so that it will run without vibration.

Oil the machine before starting and increase the speed gradually. The correct speed is usually indicated on the crank of hand operated machines but, if not, it may be calculated from the diameter of the disc which carries the cups. The diameter is measured from the bottom of one cup, through the centre of the disc to the bottom of the opposite cup with both cups held in a horizontal position. The following speeds for discs of various size create the correct centrifugal force of 30 lb. per square inch inside the test flasks:—

Diameter of Disc.	Revs. per minute.
10in.	1074
12in.	980
14in.	909
16in.	848
18in.	800
20in.	759
22in.	724
24in.	693

To find the speed of the handle, give the handle one full turn slowly, and note the number of revolutions of the disc. This figure is then divided into the revolutions desired, according to the size of the disc, and the answer will represent the number of turns per minute of the handle.

Correct speed is important, as low speeds give low readings. Slightly excessive speed is not harmful, but increases the pressure in the bottles and may cause breakages.

It is not absolutely necessary to whirl the test bottles in the centrifuge as soon as the milk and acid are mixed, but this method is much to be preferred. They may, however, be left for any reasonable time up to 24 hours without the test being spoiled; but if left until the mixture becomes cold, the bottles must be placed in hot water (about 160°F.) for fifteen minutes before whirling.

The first whirling of the test bottles is carried out for five minutes. This will bring all the fat to the surface of the liquid.

Adding the Water.

Hot water (temperature 160-180°F.) is now added by means of a pipette, or some special device, to fill the bottle to the base of the neck. The bottles are whirled again at full speed for two minutes and hot water as above is added a second time until the lower part of the fat column comes within the scale on the neck of the bottle, preferably about the 1 or 2% mark, so as to allow for the sinking of the fat column due to the gradual cooling of the contents of the bottle. This second filling of water should be allowed to fall directly on to the fat, to assist in the removal of any undissolved matter.

The bottles are now whirled a third time for one minute. This completes the test.

The above whirling times should be taken from the time the machine reaches the correct speed.

Measuring the Fat.

The correct temperature for reading the fat column is 140°F. This is important for the reason that temperatures 10-15° lower than this give low readings owing to contraction of the fat, and vice versa; also this temperature ensures that the fat column will have a sharply defined upper and lower meniscus. If several tests have been done in a hand operated machine, they should be placed in the water bath at 140°F. with the water depth equal to the height of the fat column and allowed to remain there for three minutes before commencing to read.

The water between the fat column and the mixture in the test bottle should be clear. If milky, this indicates that too little, too weak, or too cold acid has been used, and the solids not fat are not thoroughly dissolved. If black flocculant substances are present, the indication is that too much, too strong, or too hot acid has been used, or that mixing has been too violent.

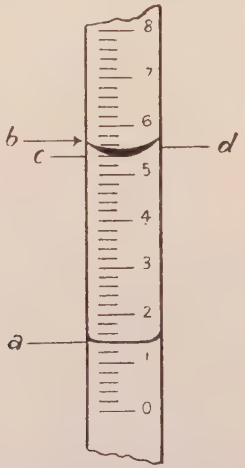


Fig. 1.—Correct method of reading the milk test. Read from a to b.

The fat column is measured from the bottom of the column to the extreme top of the meniscus as illustrated in Fig. 1. This operation is simplified by the use of the dividers, by placing one point on the bottom of the column and the other on the top of the meniscus; then the dividers are moved, without altering the distance between the points, so that the bottom point rests on the 0 mark on the scale, and the upper point gives the reading in per cent. of fat. The space between each two large divisions on the scale equals 1%, and that between each two of the smaller divisions equals two-tenths or .2%. If the fat column illustrated in Fig. 1 is examined, it will be found that the bottom of the column is on the second small graduation above the 1, and the top of the meniscus is mid-way between the third and fourth small graduations above the 5. Therefore, the per cent. of fat in this instance is 5.7 minus 1.4 = 4.3%

The reason for reading to the top of the meniscus is that it has been found by making a comparison between a large number of tests and the gravimetric analysis of the same samples, that an allowance has to be made for a small number of minute fat globules which, owing to their size, are not extracted from the mixture during whirling.

The relation between the amount of milk taken and the capacity of the graduated portion of the neck of the milk flask is as under:—

The amount of milk taken is 18 grams (17.5 c.c.). The neck of the flask is

graduated 0 to 10, and the capacity of this graduated portion is 2 c.c. Since the specific gravity of butterfat at 140°F. is .9, the weight of 2 c.c. of butterfat is 2 x .9 = 1.8 grams, and 1.8 grams is one-tenth or 10% of 18 grams. Therefore, the graduated portion of the neck, when full of butterfat, at 140°F., would represent 10% of the sample taken, and the small divisions 1% and .2%, respectively.

The quantity of butterfat contained in a definite amount of milk is calculated by means of the following formula:—

$$\frac{\text{Weight of milk in lb. x Test}}{100} = \text{lb. of fat.}$$

Hence, if a cow produces in 24 hours, 36 lb. of milk with an average test of 4.3%, the butter fat contained in this milk will be—

$$\frac{36 \times 4.3}{100} = 1.548 \text{ lb. fat.}$$

COMPOSITE SAMPLING OF MILK.

Where large numbers of different lots of milk are recorded daily, *e.g.*, the milk supply to cheese factories, or in testing herds for production, a great saving in time, labour and material is obtained by the use of composite samples.

A composite sample is a mixture of samples of various deliveries of milk from the same source, taken over a period of time, usually not more than seven days.

To ensure that a composite sample is a true representation of the milk to which it refers, it is essential that each small sample should bear a definite relation to the quantity of milk from which it was obtained.

Example.

A cow gives 20 lb. of milk in the evening and 30 lb. in the morning. To obtain an accurate mixed sample from this cow it would be necessary to take from the morning's milk one and one half times the amount taken from the evening's milk. If using a two ounce sample bottle, it is convenient in calculating the amount of the sample to be taken from the night's milk to use a definite number of c.c. per pound of milk produced, to bring the night sample as close as possible to 20 c.c. Then it will be found that the quantity of milk produced by the cow the following morning will give a sample which will be contained comfortably in the two ounce bottle. Hence, in the above example, it would be necessary to take 1 c.c. per lb. of milk produced and the quantity of the evening and morning samples would be 20 c.c. and 30 c.c., respectively. If the cow gives 7 lb. in the evening, it will be necessary to take 3 c.c. per lb. of milk and the sample will be 7 x 3 = 21 c.c.; if the following morning she gives 9 lb., the quantity of the morning sample will be 9 x 3 = 27 c.c., making the total of the composite sample 21 plus 27 = 48 c.c.

In taking composite samples of daily supplies to factories of mixed herd milk, it may be found that the quantity delivered daily by each supplier will vary by only a few pounds, and, if this is so, the same quantity sample may be taken each day. If, however, any great variation occurs, it is necessary that the quantity of the sample should vary accordingly.

Composite samples are prevented from curdling by the addition to the first small sample taken of a few drops of Formalin (40% solution of formaldehyde in water). This, however, has the effect of decreasing the solubility of the solids not fat, which may result in a curdy fat column in the finished test. Consequently, as little formalin as possible should be used, depending on the size of the sample and

the length of time it has to be kept. One drop of formalin, placed in the samples of evening milk for the purpose of herd recording, is sufficient to keep the milk sweet over night in hot weather.

Formalin is a poison, and should always be labelled as such.

Sample bottles should always be scrupulously clean and are most conveniently cleaned immediately after emptying.

THE BABCOCK TEST FOR CREAM.

Cream may be tested by the Babcock method in a somewhat similar manner as for milk. The results are accurate when the necessary care has been taken in sampling the cream and measuring the fat.

The composition of cream varies greatly according to the operation of separators, temperature and composition of milk, etc.; the fat content of supplies delivered to butter factories in this country usually ranges from 30 to 50 per cent. Because of this wide variation, and for other reasons mentioned below, the measuring of cream for the Babcock test is inaccurate, and correct results can therefore only be obtained by weighing the sample to be tested.

The specific gravity of cream is lower than that of milk, and varies according to its butterfat content; *e.g.*, the more fat the cream contains, the less a certain quantity of it will weigh.

Cream is more viscous than milk, and more of it will adhere to the sides of the pipette, especially in the case of very thick cream; also, in the case of freshly separated cream, air will be present incorporated during the separating process. With ripened cream fermentation gases developed are held in the cream. Hence, in either of the latter two cases, the weight of a certain measure is diminished. Fig. 2 shows the height to which creams of varying fat content must be raised in the pipette to get the same weight of each.

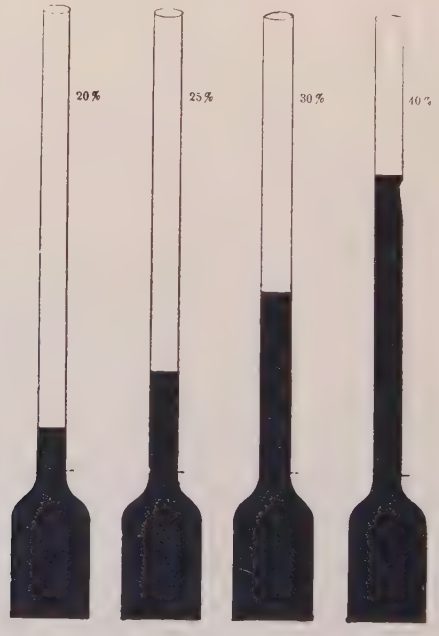


Fig. 2.

The Dairy Industry Act in force in Western Australia provides that "the butter fat content of cream purchased for the manufacture of butter shall be estimated by the Babcock method and that the samples to be tested shall be weighed with an approved scale." The technique of the cream test is as for milk, except that a 9-gram sample is taken in place of the 18 grams used in the milk test, and as the basis of the Babcock test is an 18-gram sample, and the graduations on the neck of the bottle are calculated on this basis, the final butterfat reading is doubled.

Apparatus.

The apparatus used in the cream test is as for milk, substituting cream flasks graduated 0-30 in place of the milk flasks, and using a special cream balance for weighing the samples.

Sampling.

The cream to be sampled should be well stirred to ensure an even distribution of the butter fat. This is facilitated by the use of a metal stirrer having a mushroom end which will ensure thorough mixing. In taking the sample, it is the practice in butter factories in this State to use a "thief" sampler. This is constructed on the principle of a syringe and cuts a core of cream right through the contents of the can. This core is then readily transferred to the sample bottle by pressure on the plunger.

Weighing the Samples for Testing.

The special cream balance should be set up on a firm bench, and levelled by means of the adjusting screws. This balance is a delicate mechanism, and should be kept clean and bright, with the knife edges working freely to ensure accuracy. The cream test flasks are then placed in the balance trays and the scale is balanced by adjusting the small weight provided on the beam.

The samples should be heated to a temperature of 100-120°F. by placing them in warm water; this is done to ensure ease of weighing.

When the cream is thoroughly liquified, the first sample is shaken vigorously, and having first placed a 9 gram weight on one of the balance trays, the sample is immediately transferred by means of a pipette from the sample bottle to one of the cream flasks on the opposite side of the scale. The beam of the balance is now brought to rest on the supports, the 9 gram weight is removed from the tray and the second sample is balanced against the first. Each tray on the balance holds six flasks and the above procedure is repeated until all 12 samples have been weighed. In this manner, the sample numbers will be arranged with the odd numbers on one tray and the even numbers on the other and, as most factories are equipped with steam turbine centrifuges holding 36 flasks, it is customary to weigh and test the samples in batches of this number. After weighing, the samples are arranged in trays holding 36 flasks and approximately 9 c.c. of warm water is added to each flask and mixed with the cream. The mixing may be done by shaking all flasks together in the tray.

Adding the Acid.

Fifteen to 17.5 c.c. of acid is used. The amount depends on the quantity of fat in the cream, and can only be determined by observation. The colour of the mixture is the best guide, coffee brown being correct, light brown not sufficient, and black indicating too much acid used. Samples appearing too light in colour after mixing can be corrected by the addition of a little more acid and further mixing.

Owing to the "solids not fat" content of cream being lower than that of milk, the colour of the mixture will appear light at first, and it is advisable not to whirl at once after mixing but to allow the bottles to stand for five to 10 minutes until the colour change is complete.

The flasks may now be placed in the centrifuge and the procedure from this point is similar to the milk test until the stage of reading the fat column is reached.

Alternative Method.

A modification of the preceding method is given below and is preferred by some operators for the reason that where large numbers of tests are carried out daily, a considerable saving in quantity of acid and time is achieved.

Some experience is necessary, however, with this method to enable clear fat columns to be obtained regularly.

1. Weigh 9 grams cream.
2. Add 9 c.c. sulphuric acid. Mix and allow to act.
3. Add 7-9 c.c. of hot water.
4. Whirl five minutes.
5. Add hot water to top of neck.
6. Whirl one minute.
7. Place in water bath.
8. Read.

Where steam turbine centrifuges are used, errors due to expansion of the fat may occur if the centrifuge is allowed to get too hot. Very hot tests should be cooled to 140°F. for at least three minutes before reading to obtain correct results. Conversely, using hand operated centrifuges in cold weather, tests should be placed in hot water (temperature 180°F.) for a few minutes in between whirlings, and then placed in the water bath (temperature 140°F.) for three minutes prior to reading.

Reading the Cream Tests.

Fig. 3 shows the correct method of reading the fat column in cream tests, the reading being taken from the bottom of the fat column to the *bottom* of the meniscus. This reading is doubled to give the percentage of fat.

Fig. 3.—Correct method of reading the cream test. Read from a to c.

Other precautions to be observed for the correct measurement of the fat column are the same as in the milk test.

If the cream test illustrated in Fig. 3 is examined, it will be found that the bottom of the fat column is on the 2.5 mark and the bottom of the meniscus is on the 22.5 mark.

22.5 — 2.5 = 20

20 x 2 = 40% of butterfat in the sample tested.

Relation between the quantity of cream *taken and the graduated portion of the neck of the* 18 *gram* 30% *cream flask.*

Capacity of the graduated portion	=	6 c.c.
30 graduations, each one	=	.2 c.c.
Specific gravity of butterfat at 140°F.	=	.9

Therefore, weight of fat in each division = .2 x .9 = .18 grams; .18 grams = 1% of 18 grams.

As the weight of the sample used is 9 grams, the reading must be doubled.

Eliminating the Meniscus in Cream Tests.

The meniscus in cream tests may be eliminated by the use of coloured glymol. Glymol is a white oil, lighter than butterfat, usually coloured red with Alkanet root. When added to the cream flask it levels off the top of the fat column giving a straight line at the top as well as the bottom, thus removing any doubt as to the point at which the reading should be taken.

Glymol should be added carefully by means of a pipette and allowed to run gently down the inside of the neck of the flask. If it falls directly into the fat column, it will sink into the liquid fat and, on rising, will carry some of the fat on its surface, thus decreasing somewhat the length of the fat column and giving low readings. Reading should be done immediately the glymol is added. If left, the colouring matter will combine with the surface fat, making accurate reading difficult.

The quantity of butter fat contained in a definite amount of cream is calculated as follows:—

$$\frac{\text{Weight of cream in lb. x test}}{100} = \text{lb. of fat.}$$

Hence a can containing 48 lb. of cream testing 43% would contain—

$$\frac{48 \times 43}{100} = 20.64 \text{ lb. of fat.}$$

THE BABCOCK TEST FOR SKIM MILK AND BUTTERMILK.

As mentioned previously, the Babcock test was designed originally for the estimation of fat in milk and such milk products as cream. For this purpose it is reliable. When used for testing the industry's by-products (skim milk and buttermilk) the results have been found to be considerably below those obtained by gravimetric analysis, *i.e.*, extraction with ether and weighing the fat. Early attempts at testing skim milk and buttermilk were made by using the ordinary 10% 18 gram milk test flask, but these were found to be of no value for the reason that the fat appeared merely as a few dots in the neck of the flask, and could not be measured accurately.

Later the double-bore skim milk flask (illustrated in Fig. 4) was designed, and proved very convenient for the purpose. Its use has been adopted in all countries where the Babcock test is favoured. These flasks are graduated 0-25, the space between each two marks representing .01%, and the total graduated portion .25%.

The construction of these flasks for use in Britain, as laid down by the British Standards Institution, provides for the graduated portion of the neck to contain 50 divisions, each one representing .01% and the total .5%.

The American Association of Creamery Butter Manufacturers during its study of losses of fat in buttermilk devised a test for the accurate determination of fat in buttermilk which has since been adopted as suitable also for skim milk.

Fig. 4.—Double Bore Skim Milk Flask.

The American Association Test.

This method of estimating the percentage of fat in skim milk and buttermilk makes use of a small amount of normal butyl alcohol in addition to the sulphuric acid, to promote a more ready separation of the fat from the mixture in the test flask.

Normal butyl alcohol is free from impurities and, being quite stable, is not likely to be attacked by the sulphuric acid. It does not possess a pungent or offensive odour or flavour and is more pleasant to use than other alcohols.

Directions for Making the Test.

Apparatus.

Double-bore skim milk flasks.
9 c.c. pipette for milk.
2 c.c. pipette for n-butyl alcohol.
Other apparatus is as for testing whole milk.

Place 2 c.c. n-butyl alcohol in the test flask and to this add 9 c.c. of the well-mixed buttermilk or skim milk to be tested. The temperature at sampling should be 65-70°F. Add 7-9 c.c. sulphuric acid, varying the amount to obtain a resultant fat column golden yellow in colour.

The contents of the flask are then mixed thoroughly, the flask is placed in the centrifuge and whirled at full speed for six minutes. Hot water is then added to fill the flask almost to the base of the neck, and a further whirling of two minutes is given. More hot water is added to float the fat into the graduated neck, and the flask again whirled for two minutes.

The reading is done at a temperature of 130-140°F., and the result is doubled to give the percentage of fat.

When the double-bore flask is used, it should be placed in the centrifuge with the large filling tube to the centre, so that all the fat will gather freely in the calibrated neck.

In performing the Babcock test on any milk product it is important that the water used for floating the fat into the neck of the flasks should be of a soft nature. Foam appearing on the surface of the fat column makes accurate reading difficult and is caused by the action of the acid on impurities (usually carbonates) in hard water.

If soft water cannot be obtained, the boiling of hard water will often correct the trouble, due to the fact that most of the carbonates which cause foaming will be precipitated.

Dingo Trapping and Poisoning.

A. G. Moore, Trapper, Department of Agriculture.

Foreword by A. Arnold, Chief Inspector, Vermin Department.

THE following article on the trapping and poisoning of dingoes should be read in conjunction and compared with the methods given in the Department's Bulletin No. 438 on Vermin Poisoning. It will be noted that Mr. Moore's methods differ in some details from those given in Bulletin 438, but such differences need not be given undue importance. The Department has a dozen good trappers and probably each one's methods differ slightly from the others.

Mr. Moore is a very successful trapper, and at the same time is a keen and successful poisoner of wild dogs; the capacity of excelling in both methods is not always found in the one person, as many trappers concentrate on trapping and tend to neglect the equally, if not more, important side of this work. This article, therefore, is of the greater value, and I particularly wish to draw the reader's notice to his emphasis on "smell" or rather *the absence of it;* note for instance his injunction not to spit or drop cigarette butts, etc., anywhere near the set.

A wild dog, especially one which has had some contact with man and his works, is intensely suspicious and his nose is his chief means of putting him on guard against his enemy No. 1. If anyone doubts the keenness of a dog's nose, let him remember how a domestic dog can trail his owner along bitumen roads and pavements where hundreds of other feet have trod, and then reflect that a wild dog's nose is likely to be even more keen.

ADJUSTING AND POISONING TRAPS.

The adjustment of traps is essential to avoid catching small animals such as rabbits, cats, opossums, etc. The centre of the plate should take 3 lb. weight before being sprung. This allows of the dingo's weight, and balance, to be placed

on the trap before springing it and conduces to a good "high" catch, and gives the dog no chance of springing away in time to avoid the jaws as he will do if he feels the plate giving before his weight is well placed on that foot.

This ability of the plate to carry weight is obtained by filing the tongue to a clean flat edge and by filing the under side of the catch at a slight upward angle, thus making a claw grip of the catch and tongue.

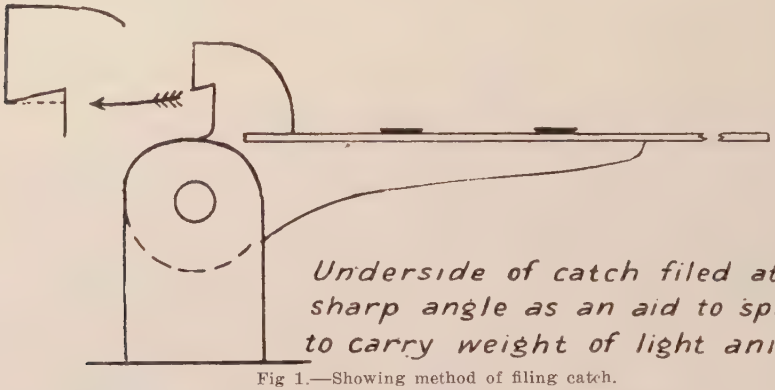


Fig 1.—Showing method of filing catch.

The catch must be filed to allow the outer edge of the plate to drop only half an inch before the trap is sprung.

Traps which are poisoned should not be staked or tied down, such staking, etc., merely increases the chance of leaving the human scent and this should be avoided. Every trap should be well-poisoned before setting; proceed as follows:—

Take a piece of brown paper 6 in. x 8 in. and double it down the centre. Put a quantity of strychnine along the centre crease after the style of making a cigarette, then roll in the same manner. Fold the two ends of this, roll back and lay the roll on the top side of the jaw, which is held down by the tongue of the trap, keeping the folded ends between the roll and the jaw and tie thereto with fine wire.

This method leaves little or no smell, is simple, clean and economical in strychnine. Any kind of strychnine, powdered or crystal, can be used. When a catch has been made, any strychnine left in the roll can be used again in a new roll. Traps must be thoroughtly cleaned and repoisoned after each catch.

Places to Set Traps.

The best places to set traps are along the dingoes' beats when travelling to water, to hunt, or to the paddocks to kill, at bushes and trees where they scratch, and along creek beds, old roads and pads. Place your decoy in the most suitable places on the windward side of your "set." An effective decoy is some dog or dingo manure set about 15 inches back from the front jaw of the trap as indicated by the guide stick just in front of the trap. (To bring his nose to the decoy, the average dog must place his foot fair on the plate.)

Setting the Trap.

In setting traps it should be remembered that in almost every district wild dogs have been "educated" by faulty traps and faulty methods of trapping, and the would-be trapper must see to it that every trap must be in good condition, well

Fig. 2.—Twigs placed on sides of location of trap to prevent dog from approaching from side; straight twig in front of trap and against pegs to ensure dog stepping over it on to plate of trap.

poisoned and most effectively set. The cunning (or educated) dog is constantly on the alert, and his ability to detect smell not natural to the place is his greatest protection; therefore the trap must be set with the least possible foreign smell.

Fig. 3.—Trap finally covered with leaves and debris so that surface appears natural. X's show pegs against which guide stick is placed.

Use a bag to stand or kneel on whilst setting the trap, and to place the earth from the trap hole on. Place the trap on the ground in the exact position it is to occupy and mark the four points with the tomahawk. Lift away the trap and drag the tomahawk from point to point, marking the shape of the trap. Then chop the ground loose, and lift out and place the soil on the bag, using a flat sided tin about 2 in. by 3 in. by about 3½ in. long for this purpose. The trap hole should be of a depth so that the plate of the set trap will be half an inch below the surface level.

Holes can be punched in the tin for sieving the soil when covering the trap, particularly in gravelly country. Stand the trap "end on" on the ground and push down the spring with the hands, allowing the clip to slip down on the spring, then repeat with the other end. The jaws can now be opened easily. Hold the plate firmly, and gently tap the tongue forward with the tomahawk to make sure the catch and tongue are properly engaged.

Now place the trap in the hole with the "free" jaw facing the dog's approach and the poisoned jaw nearest the decoy, and slip the safety clips back along the springs with the thumbs. Lift up the free jaw (the one nearest you) and place a piece of wood the length of the jaw beneath it so that when resting firmly on the wood the jaw comes level with the plate. This allows the soil to pack firmly around the jaws and accelerates the speed of the trap by having only one jaw in contact with the springs to start off with.

Place the earth firmly around the jaws and springs, using the tin and being careful not to use the hands. Place two small pegs in the ground half an inch out from the corners of the jaw nearest you (see Fig. 3); these act later as trap position marks, and also keep the guide stick from being knocked on to the trap. Place eight little sticks or blackboy tops about as thick as a match and three inches long across from the jaws and springs to the plate of the trap. These support the paper and prevent small animals from breaking through the paper during wet weather. (Fig. 4.)

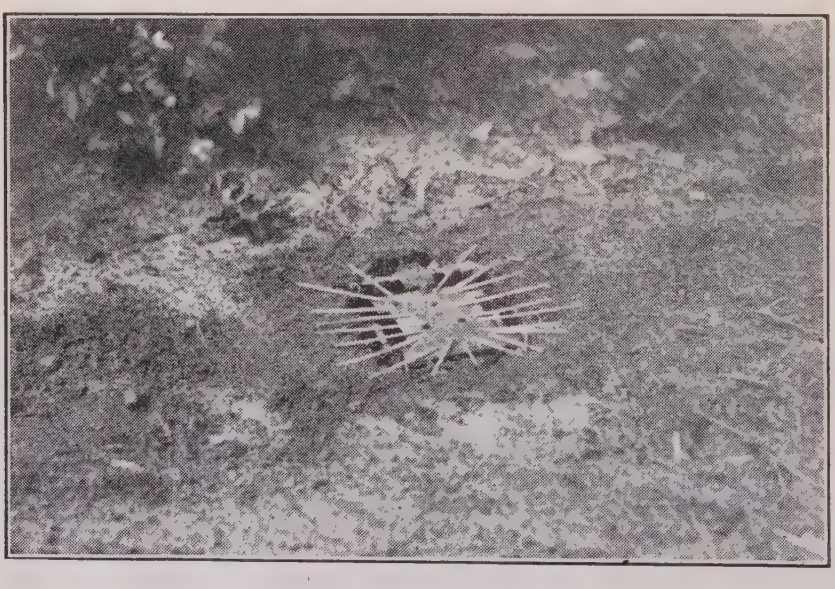


Fig. 4.—Trap prepared with twigs to carry weight of paper with covering soil.

Use a single sheet of paper about 8½ in. by 9 in. for a 7 in. trap. The single sheet keeps the smell down better than two pieces.

Some of the earth is now sieved on to the paper and the weight of it takes the paper down flat on to the plate and gives a clear patch. Put the earth on evenly with the tin, using the side of the tin to pack the earth firmly over the paper and springs. This prevents rain from washing the paper bare, keeps down any smell on the trap and prevents the dog from feeling the trap with his feet.

For final covering, use fine pieces of broken leaves which wash around bunches of grass, or washed surface sand, in sandy country; old ant nest material may also be used. Lay the guide stick in front of the two little pegs in front of the trap. (See Fig. 2.) Use a stick about half an inch thick and 12 inches in length.

Some end pieces of scrub or fine ends of limbs can be stood up in the ground on each side of the trap, forward as far as the guide stick, as natural as possible, and a few further back, just leaving an entrance over the guide stick and trap to the decoy.

Take the bag and the remainder of the earth removed from the trap hole some distance away before tipping it out and take care during the setting of the trap not to walk about more than necessary, or to spit about or drop cigarette butts, pieces of paper, etc.

In some districts kangaroos are troublesome as they will eat dog manure for the minerals. Take carefully prepared bath water of a dog, not using soap or hands, and sprinkle the trap and decoy. Dog or dingo's feet wash is best as a dog sweats at the feet. The doggy smell keeps the kangaroos away and makes a good dingo decoy also. A paint brush can be used for the purpose of sprinkling the ground with the wash water.

Traps should be left at least three days in summer and five days in winter before inspection. (Natives can often be shown how to set traps, and, in fact, they do so and camouflage them perhaps better than the white man. However, they will usually visit them the next day to see results, their gins will visit them the following day and their picaninnies the subsequent day; the result being that the human odour is so strong that dogs will not come near the traps.) When setting traps without decoy on pads or old roads, set them just the same as with decoy, but always set them lengthways in the pad; the plate value is much greater and the jaws close in from the sides of the pad, making it impossible for the trap to be sprung without making a catch. After setting, place a guide stick across the pad two inches from the jaws of the trap. The pad can be narrowed in by standing some dry pieces of scrub in the ground, but do not use limbs with dry leaves on. Do not set traps crossways in pads or old roads. This is an old practice and is undoubtedly responsible for so many wild dogs being educated and difficult to trap, and I cannot stress this point too strongly.

The method advocated in this article has been worked out and tested over many months' experimenting, using a dingo kept for the purpose, and tried out in every way in order to evolve a thorough and successful method of trapping wild dogs.

DESTROYING DINGO PUPS.

Pups are found in many different places, usually within a mile of fresh water. The most likely places are outcrops of rocks, dens, bulrush swamps, paperbark lakes, creeks, rivers and at times, on the plains in bunches of scrub or mallee.

When small pups are found it is very simple to catch the mother. Put the pups in a bag, tie the mouth and leave them in the den; (always pick up the pups by the back of the neck). Place the traps at the entrance or approaches to the den. The bagged pups will make plenty of noise and the mother will make a big effort to reach them, regardless of smell, and is caught.

If the pups are too big when found, and run away, set your traps some distance away on leads to the den, such as creek beds, old roads, pads, etc. When the mother is caught the pups can be destroyed by poison baits and by poisoning any meat the mother has left for them about the den, or can be shot or trapped.

Sometimes two or three families will unite, making anything up to 15 pups in the one den. If the pups are small enough to handle, just leave three pups bagged in the den, one from each litter; these can be fed each day with sugar and water and bits of meat until all the mothers are caught. In such cases it is advisable to set traps on leads at a distance from the den as well as on the near approaches to the pups.

MAKING OF BAITS FOR POISONING DINGOES.

Suet Baits.

The bait recommended is the small suet bait. It stands the sun and weather well, and is not often taken by ants. Cut the suet into a pot or billy-can and place over a hot open fire for about 30 seconds. This gives the baits a burnt or "crackling" smell which is most attractive to and liked by dingoes.

Mash or mix the hot suet to a paste and when cool enough, cut into small pieces about the size of the first joint of the thumb, or as round as a shilling piece; place each bait on a piece of paper about 2½ in. square (apple wrapping paper preferred), flatten the suet and place in the centre sufficient strychnine to lightly cover a 3d. piece, or to cover ¼ in. of the small blade of a pocket knife heaped up. Then squeeze up and roll between the thumb and first two fingers, keeping the poison in the centre of the bait.

The small *Blood Bait* is made in the same way. When the suet is brought to a paste as above, add ½ lb. of fresh blood to 2 lbs. of suet and stir in sufficient pollard (about two-thirds of a cupful to above quantities). These baits can be placed into apple wrapping paper or into longer pieces of brown paper and unwrapped before being laid. These baits dry hard, keep well and give good results. Always place baits in the shade if at all possible.

For *Meat Baits,* the legs of rabbits, dried through being hung up for a few days, make good baits, and you thus utilise one class of vermin in order to destroy another.

Where to Lay Baits.

Lay poisoned baits along beats, leads, creeks, rivers and at springs, dams, lakes and swamps; also on their breeding grounds, hunting grounds, on pads, old roads, at road junctions, fence corners and wherever dogs scratch or camp.

Flax and Linseed Breeding in W.A.

WADA, A NEW RUST RESISTANT FLAX VARIETY.

I. Thomas, Superintendent of Wheat Farming.
A. J. Millington, Plant Geneticist.

PLANT breeders in Australia have been concerned chiefly with the development of new varieties of Old World crops suited to local conditions. The future of wheat in Australia was most unpromising in the 70's of the last century, but the development of varieties much earlier maturing than the English and South African types then available completely altered the economics of the industry. The earlier maturing varieties made possible the cultivation of wheat in the drier interior, where land was freely available in extensive areas and rust was seldom a problem. In Western Australia in particular our agriculture is almost entirely dependent on introduced plants which arrived either fortuitously or by design, and specific strains have been developed for local conditions in crops as diverse as wheat, oats, potatoes, runner beans, carrots and sub-clover.

LINSEED CULTIVATION IN W.A.

When attempts were made during the war years to establish flax and linseed as commercial crops in W.A., no varieties specifically bred for W.A. conditions were available. The linseed variety Punjab, an Indian type grown extensively under irrigation in California was introduced and cultivated for seed production. Because of susceptibility to a local rust race and the relatively late maturity which made the seed bolls very subject to cutworm attack, the production of Punjab proved uneconomical and the attempt to establish linseed growing as an industry in W.A. failed. The growth made by Punjab in the absence of rust and cutworms indicated that yields at least as high as those obtained under dry land conditions in most other linseed growing countries should be obtained when a variety suited to local conditions was available. The development of such a variety is being undertaken at the Avondale Research Station, and several very early maturing and rust resistant strains are being increased for commercial testing. Although it is unlikely that even the earliest maturing linseeds will escape damage from cutworms in every season, they are much less liable to attack (Table 1). Promising results have also been obtained by Jenkins (1945) with the new insecticides such as D.D.T., which are very economical in use.

Table 1.—Avondale Research Station, 1944.

Variety.	Maturity.	% Bolls Damaged.
Riga Crown	Very Early.	25
Italian	Early.	43
Walsh*	Midseason.	70

* Walsh is of much the same maturity as Punjab.

The linseed breeding programme has been materially assisted by the New South Wales Department of Agriculture making available its large collection of varieties and crossbreds.

FLAX BREEDING.

Since flax and linseed are varieties of one plant species developed for fibre and seed production respectively, they are subject to attack by the same diseases and pests. Rust and cutworms have added materially to the cost of producing flax in this State and the prospects of the industry are to a large extent related to the development of satisfactory controls for them.

Cass Smith and Millington (1944) in a review of wheat rust, state that it over-summers almost entirely on volunteer plants and grasses and consequently seldom reaches epidemic form in W.A. unless there is considerable summer or early autumn rain. Earlier work by Cass Smith (1942) showed that flax rust carries over in much greater quantity because most infected straw is capable of causing infection in the subsequent season. As the terminal branchlets of the plant are usually the most severely attacked (Fig. 1) the seed yield is markedly reduced in even moderate rust epidemics. It is generally considered that straw quality is reduced by the presence of rust. Elsewhere in this Journal is a review of the rust races in W.A. by the Plant Pathologist, Mr. W. P. Cass Smith.

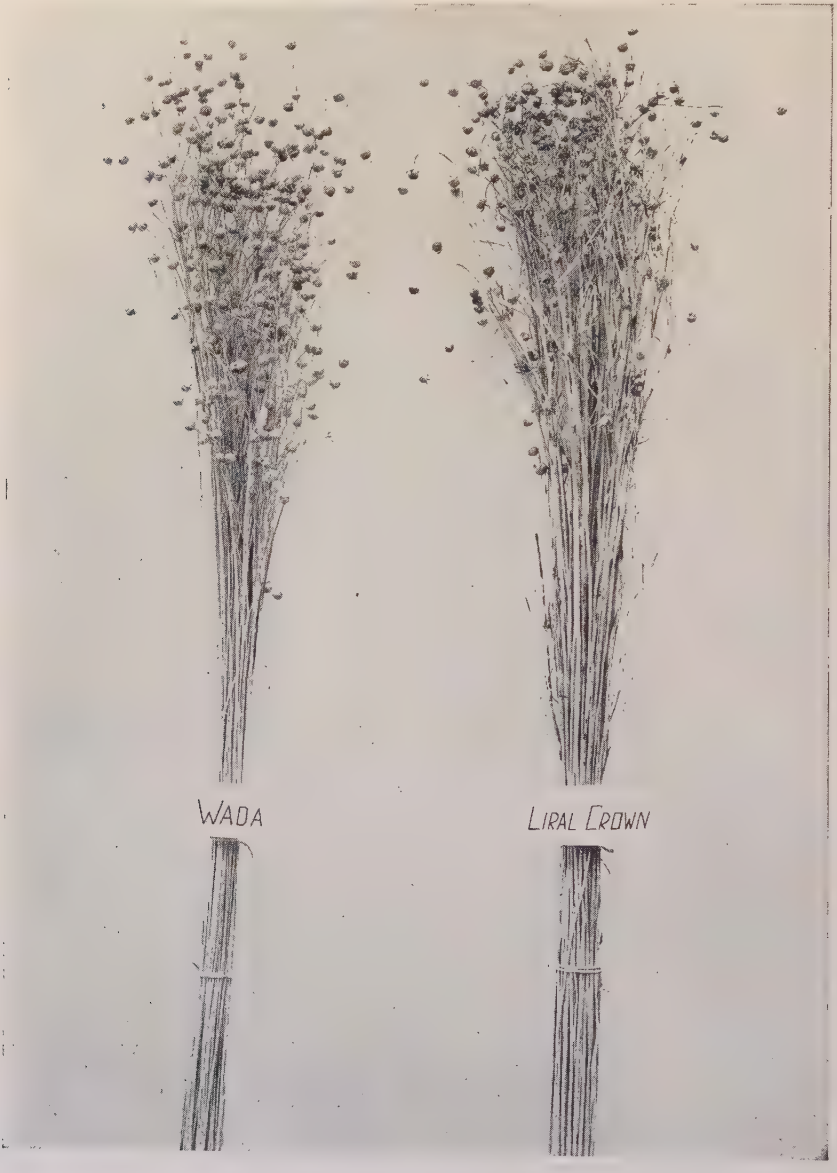


Fig. 1.—The rust infection is heaviest on the terminal branchlets, many of which on Liral Crown have broken off. It can be seen that there are no rust pustules on Wada.

Elliott has stated (1944) that cutworms have materially reduced the seed yields of flax crops and in severe epidemics have eaten the straw at the site of the rust pustules.

Flax Cross-breeding.

A number of the available linseeds are immune to rust in Australia and crosses between these and the commercial flaxes will give resistant flax type progeny. This approach is being actively undertaken in several States, and the programme includes repeatedly back-crossing the resistant crossbred progeny to the flax parent and retaining the resistant plants. The end product of such a programme is a variety identical with the flax parent except in respect to rust resistance.

Selection from Varieties.

Most flax varieties comprise a mixture of types, since they have not been pure lined as has been the case with the popular cereal varieties.

The possibility of their containing rust resistant types was therefore investigated by raising a large collection of varieties in the rust liable districts. The variety Riga Crown which originated in the Baltic States was found to contain a small percentage of rust resistant plants. These have served as a basis for the variety Wada, bred by one of the authors of this article, A. J. Millington, which it is hoped will be released for commercial increase during 1946.

Fig. 2.—Wada is usually taller than Liral Crown and Riga Crown but is shorter than Concurrent.

Wada is an early maturing variety similar in growth habit and appearance to Liral Crown, but usually slightly taller growing as will be seen from Fig. 2. The earlier maturity and immunity to rust will make it less subject than Concurrent to cutworm damage.

Rust resistant selections have been developed from crosses between Wada and Concurrent for testing against the former variety for yield and fibre quality.

Fibre Quality.

Although the farmer is concerned more directly with fibre quantity and yield of straw per acre, considerations of quality may determine the extent of the industry in the future.

Fibre quality is very difficult to define and is dependent on a number of environmental factors such as soil type, season, rate of seeding, time of planting and harvesting, etc., besides variety. From the viewpoint of plant breeding, it is therefore essential to have some appreciation of the influence of these factors on both the fibre quality and the variety. These factors are being actively investigated by the Agrostological Section of the Dairy Branch.

ACKNOWLEDGMENT.

Appreciation is acknowledged of the assistance of Officers of the Dairy, Plant Pathology and Entomological Branches in defining the objectives of the flax and linseed breeding programme, whilst the trials of the new variety conducted and reported on by Messrs. H. K. Gibsone, H. G. Elliott, W. P. Cass Smith and H. L. Harvey have been most valuable. Thanks are also due to Dr I. A. Watson of Sydney University for his seedling resistance tests. These have served to confirm our knowledge of the resistance of the new variety. The breeding of rust resistant flax varieties has been actively sponsored by the Flax Production Committee which has convened a conference of flax breeders each year.

REFERENCES.

Elliott, H. G. (1944): Unpublished data.

Cass Smith, W. P. (1942): Flax Rust. *Jnl. W.A. Dept. Agric.*, Vol. XIX.

Cass Smith, W. P., and Millington, A. J. (1944): Stem Rust of Wheat and its Control by Breeding Resistant Varieties. *Jnl. W.A. Dept. Agric.*, Vol. XXI.

Jenkins, C. F. H. (1945): D.D.T. as an Agricultural Insecticide. *Jnl. W.A. Dept. Agric.*, Vol. XXII.

Flax Rust in Western Australia.

W. P. CASS SMITH, Plant Pathologist.

H. L. HARVEY, Assistant Plant Pathologist.

FLAX rust is caused by a fungus *Melampsore lini*, and it occurs in all parts of the world where flax is cultivated. The disease was first recorded in Western Australia in 1931, but it was of no economic importance here until the recent World War, when flax was first cultivated commercially. During the war years, increased production of flax for fibre became an urgent matter and a considerable area was soon planted. The cultivation of linseed was also attempted during the same period.

Experience soon showed that flax rust was a disease to be reckoned with for yearly since the 1941 season, it has proved a major limiting factor to economic crop production, and therefore to the permanent establishment of a peace-time industry.

Linseed crops of the Punjab variety grown in the Avon Valley districts have been so severely damaged by flax rust, that the disease has been largely responsible for the temporary failure to establish the industry here.

On the fibre varieties, the damage has not been so serious. Nevertheless, losses varying from slight to total crop failure have been noticed. In 1942 the disease was responsible for an estimated reduction of 20 per cent. in straw yields, plus a 10 per cent. reduction in straw values over an area of approximately 8,000 acres (1). Experience throughout the world has shown that once flax rust becomes widespread, it can only be controlled satisfactorily by the use of resistant varieties and, fostered by the Commonwealth Flax Production Committee, investigations have been carried out both in Western Australia and in other States of the Commonwealth with this end in view.

RACES OF FLAX RUST—THEIR IDENTIFICATION AND DISTRIBUTION.

The breeding of resistant varieties is complicated by the fact that the flax rust fungus is a highly specialised parasite which comprises a number of races. These races vary in their ability to attack different fibre or linseed varieties, and so a variety which is immune to one race of the fungus may be very susceptible to another race.

To complicate matters further, the distribution of the rust races is not uniform in all localities. (See page 44.) For example, in the Boyup Brook area, the centre of the fibre flax belt, the fibre variety Concurrent becomes heavily rusted when conditions are favourable for disease development. However, in the Northam area where linseed varieties only have been cultivated, it has been grown in small plots without a trace of rust. This does not mean that Concurrent is rust resistant in the Northam area; it merely indicates that a rust race which attacks it is not yet present or not sufficiently widespread in that locality. Were Concurrent widely grown in the Northam area, there is little doubt that sooner or later it would develop rust owing to the spread of races to which it is susceptible. It follows, therefore, that a variety cannot be regarded as rust resistant until it has been tested against all races of the fungus occurring here.

The continued collection, and accurate identification, of rust races is, therefore, an important corollary to the breeding of resistant varieties.

In Australia, the onerous work of identifying the races of flax rust has been carried out by Dr. W. L. Waterhouse and Dr. I. A. Watson of Sydney University (2). Rust collections forwarded from the various States are grown on seedlings of a standard set of "differential" flax and linseed varieties in the glasshouse and the reactions to the disease are noted. If two samples of flax rust collected in different localities produce exactly the same reactions on the "differential" varieties, the component races are regarded as identical. If the reactions differ on one or more varieties, however, different races are involved. By comparing the reactions produced by a newly collected rust sample with those previously recorded from other localities, the rust can be identified as either a new or a known race.

After identification, every endeavour is made to propogate the various races permanently, so that they will be available for testing the resistance of new selections or crossbred material.

In 1941 when commercial flax cultivation was first undertaken here, little was known of the distribution of flax rust or the number of component races in Western Australia.

From rust collections forwarded—in the making of which many colleagues have assisted—six races of the fungus have now been identified from W.A. (3) (4), whereas ten races have been tentatively determined for Australia and New Zealand. The local rust races were collected from either commercial varieties or "wild flax" and these, together with the localities in which they were obtained are as follows:—

RACE A—Boyup Brook, Northam, Merredin, Beverley, Avondale, West Wagin, Woodman's Point, Wagin, Narrogin, Brookton Road, Bremer Bay, Kojonup, Wongan Hills, Toompup, Yarloop, East Bremer Bay.

RACE B—Boyup Brook.

RACE C—Boyup Brook, Roelands.

RACE D—Boyup Brook.

RACE E—Boyup Brook, Yarloop, Scott's Brook, Cookernup, Pinjarra, Mayanup, Mumballup, Kulikup, Donnybrook, Beelerup, Wokalup, Muradup.

RACE G—West Bremer Bay.

Race A is typically a rust of linseed varieties, such as Punjab, and it caused severe damage to this variety when grown commercially in the Avon Valley districts.

Races B. C. D and E attack the fibre varieties such as Concurrent and Liral Crown and of these Race E is the most virulent.

Race G, which has so far only been recorded in this State from West Bremer Bay, resmbles Race A in that it is mainly a rust of linseed varieties.

WILD FLAX IN RELATION TO THE DISEASE.

In addition to attacking cultivated flax varieties, the flax rust parasite also attacks certain "wild flax" species. Two "wild flaxes" occur here namely, *Linum marginale* and *L. gallicum*. The former is a native perennial plant which is widely distributed, whereas the latter is an introduced annual of limited occurrence. In South-eastern Australia, *L. marginale* has long been known as a host of flax rust but in Western Australia the disease had not been recorded on this host, when commercial flax cultivation was first undertaken during the war years.

Because of its wide distribution and perennial habit, it was thought that *L. marginale* might play an important part in harbouring the fungus from year to year and spreading the disease to commercial crops. "Wild flax" surveys were, therefore, undertaken in conjunction with the Government Botanist, Mr. C. A. Gardner, as a result of which an even wider distribution of the species was discovered (5), (6).

Specimens affected with rust were discovered in a number of localities and, from these, three races have been identified, namely, races A, E, and G. Of these, Race A appears to be most widely distributed on "wild flax," having been found at Woodman's Point, Wagin, West Wagin, Narrogin, Brookton Road, Bremer Bay, Kojonup. Race E has been found at Scott's Brook and Race G at West Bremer Bay.

It is also of interest to note that "wild flax" was found occurring most abundantly in the Boyup Brook and adjacent districts, and that here four out of the five known rust races have been recorded, the greatest number in any locality. In addition to harbouring rust, therefore, it appears likely that *L. marginale* may play an important part in the production of new races, by natural crossing.

Unlike *L. marginale,* the annual *L. gallicum* appears to be immune to local rust races for no rusted specimens have as yet been discovered in this State.

RUST INDICATOR PLOTS.

To facilitate the discovery of new races, and to investigate more fully the distribution of those already recorded, the planting of "rust indicator" plots in numerous localities was commenced in 1943, and is still being continued each season.

At each site, a similar group of flax and linseed varieties is planted, including commercial varieties, some of the "differential" set used in the glasshouse for race-determination, together with others of interest to the plant breeder.

The sites chosen are not confined to the commercial fibre flax and linseed growing areas, but they include other localities far removed, where "wild flax" is known to exist.

In all but a few plots, rust has developed each year, at least on certain varieties, allowing valuable rust collections to be made. The use of "rust indicator" plots has simplified the detection and collection of rust in "wild flax" areas, for owing to its sporadic occurrence *L. marginale* is difficult to locate and therefore rusted specimens may easily escape notice.

Information of interest from the plant breeding aspect has also been obtained from this work, for certain varieties including Ottawa 770B and Argentine Selection (C.I. No. 462) have shown immunity at all sites. Others including Uruguay 36/48 have shown high resistance throughout, while immune variants were noted in a number of other varieties.

The performance of immune or resistant varieties such as these is watched with interest from year to year, for any departure from the normal rust reaction will indicate the appearance of a new race.

It is also of interest to note that the new variety Wada* showed freedom from rust at all sites last season, a result which helps to confirm the resistance of this variety as indicated by glasshouse tests at Sydney Unversity.

Acknowledgment.

Grateful acknowledgment is made of the help received from Messrs. H. K. Gibsone, H. G. Elliott, A. J. Millington and other colleagues who have assisted with rust collections and in other ways. Thanks are also given to Messrs. F. C. West of Toompup, G. Baty of Bremer Bay, E. Doncon of Grass Valley, and T. Eastcott of Boyup Brook School, and others who have rendered invaluable assistance in connection with the planting of "rust indicator" plots.

* See article in this issue by I. Thomas and A. J. Millington, "Wada, a New Rust Resistant Flax Variety."

References.

1. Elliott, H. G. Private Communication.

2. Waterhouse, W. L. and Watson, I.A. 1941. A Note on Determinations of Physiological Specialisation in Flax Rust. Jour. & Proc. Roy. Soc. New South Wales, 75, pp 115-117.

3. ——————————— 1944. Further determinations of Specialisation in Flax Rust caused by *Melampsore lini* (Pers.), Lev. Jour. & Proc. Roy. Soc. New South Wales, 77, pp. 138-144.

4. ——————————— 1946. Private communication.

5. Gardner, C. A., 1942. Wild Flax, Jour. Dept. Agri. West Aust. 19, pp. 231-235.

6. Cass Smith, W. P., 1942 Flax Rust, Jour Dept. Agric. West Aust. 19, pp 240-242.

Wheat Variety Trials on the Research Stations.

I. Thomas, Superintendent of Wheat Farming.

A. J. Millington, Plant Geneticist.

WHEAT Variety Trials were conducted at the five wheatbelt Research Stations and in each instance two plantings were made, one of mid-season vareties sown during the first fortnight in May, and one of early or very early varieties planted towards the end of that month. The two leading varieties in the State in their respective maturity classes, Bencubbin and Bungulla, were used as controls.

Yields, except at the Merredin and Salmon Gums Research Stations, were rather low and in general the later plantings yielded rather better than the earlier ones.

Bencubbin and Bungulla remain the most prolific varieties under test, although, at the Salmon Gums Research Station, the crossbred W.19 has equalled the former variety in each of the last two years. Because of its low yield at the other Stations it is not proposed to release W.19 as a variety.

Of the four rust resistant varieties, Charter, Eureka, M.60 and M.62 under test, the best yields have been recorded by the first mentioned. In view of their relatively low yields and indifferent flour strength it is proposed to discard the crossbreds M.60 and M.62.

THE SEASON.

The season was characterised generally by a rather late opening which was followed by, in some instances, the wettest June on record. July rainfall was in most instances below average, whilst August was exceptionally wet. There was an absence of finishing rains but crops generally yielded better than was anticipated.

VARIETAL NOTES.

Very Early Maturing Varieties.

Bungulla.—The acreage sown to this variety has increased very rapidly and it is now the third leading wheat in Western Australia. It is the most prolific early, or very early, variety under test, but for most satisfactory results it should not be planted before the fourth week in May or the first week in June. Bungulla is resistant to Flag Smut but susceptible to rust, although it tends, because of its early maturity, to escape the latter disease.

Charter.—This variety was released in 1944 by the New South Wales Department of Agriculture and was derived from a cross between Kenya and Gular. It is a tall growing variety which has proved satisfactory for hay. The grain is normally very hard and translucent, with less tendency to mottle than is the case with Eureka. The grain of Charter frequently yields flour of premium strength. Unlike Eureka which is susceptible to the new rust strain which has appeared in New South Wales, Charter is resistant to all Australian rusts. It is the most prolific of the rust resistant varieties at present under test, but the yields generally are below those obtained from Bungulla.

Early Variety.

Koorda.—The most satisfactory yields have been obtained with this variety on the light land at Wongan Hills Research Station, where its excellent straw strength makes for ease of harvesting. Koorda is almost immune to Flag Smut but susceptible to rust.

WHEATBELT RESEARCH STATION RAINFALL.

Research Station.	Period.	Jan.	Feb.	Mar.	April.	Growing Period.							Nov.	Dec.	Annual Total.
						May.	June.	July.	Aug.	Sept.	Oct.	Total.			
Avondale ...	1945 ...	...	1	134	43	188	1,083	193	528	127	7	2,126	86	10	2,400
	Average ...	26	40	111	79	221	327	299	252	107	80	1,287	46	34	1,622
Chapman ...	1945 ...	...	29	25	15	283	939	233	381	149	19	2,004	33	27	2,133
	Average ...	28	39	68	72	233	427	384	267	148	85	1,547	35	27	1,815
Merredin ...	1945 ...	...	2	105	31	107	431	90	305	83	8	1,024	7	26	1,195
	Average ...	45	57	98	88	137	192	179	154	81	74	818	40	60	1,206
Salmon Gums	1945 ...	10	6	29	93	59	346	100	112	123	3	743	22	140	1,043
	Average ...	91	71	149	92	130	149	142	152	90	111	774	88	84	1,348
Wongan Hills	1945 ...	...	41	69	71	165	629	214	416	124	14	1,562	48	30	1,821
	Average ...	36	49	100	87	189	263	252	207	95	69	1,075	41	45	1,432

WHEAT VARIETY TRIALS.
1945

LATE SOWN SECTION

Variety.	Maturity relative to Koorda.	Rust Reaction.	AVONDALE RESEARCH STATION. 1945 Yield.	AVONDALE RESEARCH STATION. Per cent. Control. 1945.	AVONDALE RESEARCH STATION. Per cent. Control. 1944-5.	CHAPMAN RESEARCH STATION. 1945 Yield.	CHAPMAN RESEARCH STATION. Per cent. Control. 1945.	CHAPMAN RESEARCH STATION. Per cent. Control. 1944-5.	MERREDIN RESEARCH STATION. 1945 Yield.	MERREDIN RESEARCH STATION. Per cent. Control. 1945.	MERREDIN RESEARCH STATION. Per cent. Control. 1944-5.	SALMON GUMS RESEARCH STATION. 1945 Yield.	SALMON GUMS RESEARCH STATION. Per cent. Control. 1945.	SALMON GUMS RESEARCH STATION. Per cent. Control. 1944-5.	WONGAN HILLS RESEARCH STATION. 1945 Yield.	WONGAN HILLS RESEARCH STATION. Per cent. Control. 1945.	WONGAN HILLS RESEARCH STATION. Per cent. Control. 1944-5.
			bus. lb.			bus. lb.			bus. lb.			bus. lb.			bus. lb.		
Bungulla	— 7	Susceptible	17 52	100	100	10 32	100	100	27 42	100	100	20 54	100	100	16 29	100	100
Charter	— 6	Resistant	14 8	75	....	11 27	109	97	25 6	91	88	18 14	87	....	11 50	72	71
Koorda	=	Susceptible	15 17	86	86	10 47	102	85	21 42	78	78	20 58	100	88	12 16	74	84
M.60	=	Resistant	17 9	96	89	11 35	110	91	23 50	86	82	18 34	89	84	14 56	91	86
M.62	=	Resistant	13 25	75	....	10 5	96	91	21 20	77	....	17 20	83	80	12 26	75	77
Diff. for Significence (P + ·05)			....	....	....	....	....	....	32	2	....	1 12	6	....	1 16	7	....

EARLY SOWN SECTION

Bencubbin	+ 8	Susceptible	9 36	100	100	9 42	100	100	25 28	100	100	21 4	100	100	6 58	100	....
Eureka	+ 6	Resistant	10 45	112	84	10 45	111	77	21 57	86	80	19 47	94	84	5 26	78	....
Kondut	+10	Moderately Susceptible															
W.19	+10	Moderately Susceptible	9 41	100	90	10 59	113	90	18 22	72	67	19 22	92	83	5 14	75	....
M.60	=	Susceptible	9 9	95	92	8 43	90	78	....	....	....	21 17	101	99	5 15	75	....
M.62	=	Resistant	....	....	....	....	....	....	21 52	86	....	....	....	....	....	....	....
		Resistant	....	....	....	....	....	....	21 15	83	....	....	....	....	....	....	....
Diff. for Significence (P = ·05)			....	....	....	1 2	10	....	2 12	9	....	1 17	6	....	1 24	20	....

Mid-season Varieties.

Bencubbin.—This remains the most extensively grown variety in Western Australia, and it has given more satisfactory yields than any other mid-season variety under test. Bencubbin is resistant to Flag Smut but susceptible to rust.

Kondut.—On the whole, yields obtained from this variety are less than those of Bencubbin, but this may, in part be due to its slightly later maturity. The straw strength of Kondut is excellent and it frequently yields flour which is above the f.a.q. for the State, in respect to strength. Kondut is resistant to Flag Smut, and appears to be less susceptible to rust than Bencubbin.

Eureka.—The yields obtained from Eureka have been, on the whole, rather disappointing, particularly under conditions of low rainfall or low soil fertility. The grain is normally translucent, but it frequently mottles badly. In all tests in Western Australia, Eureka has proved resistant to rust, but in New South Wales it is very susceptible to a new strain which has appeared. The straw strength of Eureka is very satisfactory, and it also possesses resistance to Flag Smut.

ACKNOWLEDGMENTS.

The authors gratefully acknowledge the assistance of the farm managers in conducting the trials and supplying the yield data.

Avondale Research Station—Mr. W. A. Human.

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Thanks are due also to the Conservator of Forests, Mr. T. N. Stoate, for the statistical analysis of the results.

Superphosphate Rationing in Western Australia

1941-42 to 1945-46.

By L. J. H. Teakle and D. J. Collins.

AUSTRALIA normally obtains supplies of phosphatic rock for the manufacture of superphosphate from Nauru and Ocean Islands, in the Pacific Ocean. On these islands is an estimated 150 million tons of the highest grade phosphatic rock in the world. From this can be manufactured superphosphate of excellent quality with a guaranteed phosphoric acid (P_2O_5) content of 23 per cent. A 24 per cent. grade can be obtained by selection of the phosphatic rock.

With the uncertainty of supplies arising out of the war conditions in 1939, the Commonwealth Government arranged for a 12 months' reserve of rock phosphate to be built up in the Commonwealth. All of the business with relation to the supply and handling of the phosphate supplies for Australia was left in the hands of the British Phosphate Commission and the Department of Commerce and Agriculture. The farmers of Australia are indebted to the efficient service which these authorities, acting through the Phosphate Committee, have rendered to them during the difficult war period.

The first actual break in supplies resulted from the damage caused when installations on Nauru Island were shelled by a German raider on 27th December, 1940. The interference with the handling of phosphatic rock at Nauru, combined with other difficulties, led to restriction in supplies and the Commonwealth Government decided that it would be necessary to reduce the allocation to farmers throughout the Commonwealth in 1941-42. In this year, no formal rationing scheme was devised, but farmers were restricted to 60 per cent. of their normal usage, as indicated by their purchases in 1939-40.

Japan's entry into the war on 7th December, 1941, resulted in the loss of Nauru, Ocean, and Christmas Islands in the Pacific Ocean. This aggravated the shortage of phosphatic rock, and necessitated the formulation of a systematic scheme of rationing throughout the Commonwealth under National Security Regulations. Arrangements were made to obtain supplies of phosphatic rock from Egypt and the British Phosphate Commission explored all possible sources for Australian supplies. Small tonnages of local rock were utilised in South Australia and Western Australia. Unfortunately the local and Egyptian phosphatic rocks were of poor quality, and even by mixing with a certain amount of the reserves of high-grade rock from Nauru and Ocean Islands, it was not possible to maintain a guaranteed phosphoric acid content above 18 per cent. P_2O_5. In some instances it was necessary to drop the guarantee to 17 per cent. P_2O_5.

Besides being of low phosphoric acid content, the Egyptian rock proved unpleasant to handle, and its high salt content resulted in the formation of hydrochloric acid in the production of superphosphate and manufacturers and farmers have been faced with a severe problem due to the rotting of bags. The setting of the product when treated with ground limestone to reduce the damage to the bags, caused by the hydrochloric acid, has constituted another difficulty.

During the rationing period, the quota of superphosphate in Australia from year to year was dependent on the availability of shipping and the supply position in Egypt, and the amount allocated was decided by Allied policy. Each year the Department of Commerce and Agriculture presented a case for the supply of superphosphate and pressed the claims of Australia for this important fertiliser as the basis of food production in the Allied war effort. The year 1939-40 was adopted as the base year throughout Australia and allocations were made to the States by the Department of Commerce and Agriculture on a scale determined by the Agricultural Council. The scale was in the ratio determined by the tonnage purchased by the States and used for the various crop categories in the base year.

Under National Security Regulations, the permanent head of each State Department was given the authority to ration fertilisers and the responsibility for devising a rationing scheme for the respective States and the determination of the quota available to each farmer. No fixed Commonwealth-wide method for fertiliser rationing within the States was decided, but each State authority was free to devise a scheme adaptable to local conditions, to ensure that each farmer would receive an equitable quota.

The quantity of superphosphate available for Australia in 1942-43 was 480,000 tons, which is 50 per cent. of that sold in the base year—1939-40. For Western Australia, the quota in 1942-43 was 119,700 tons, as compared with 264,500 tons in 1939-40. Western Australia's share in the Australian quota was only 45.2 per cent. of the 1939-40 usage, owing to the effect of reservations for priority crops in Western Australia being lower than the average for other States.

QUANTITY OF SUPERPHOSPHATE AVAILABLE.

The quantity of superphosphate available for the Commonwealth and for Western Australia in each year since the war began, is given in Table I.

Table I.

Year.	Commonwealth.	Western Australia.
1939–40	960,000	264,690
1940–41	920,000	245,807
1941–42	672,000	177,200
1942–43	480,000	119,700
1943–44	520,000	121,404
1944–45	800,000	195,755
1945–46	1,140,000	265,818

RATIONING OF SUPERPHOSPHATE IN WESTERN AUSTRALIA.

For rationing purposes, crops were divided into three categories:

1. Priority crops: These were of particular importance in Australia's part in the war effort.
2. Orchards and vineyards.
3. Non-priority, or general farming, crops.

In order to illustrate the distribution of superphosphate among these categories, the figures for 1942-43 may be cited:

	Tons (estimated).
1. Priority crops	12,200
2. Orchards and Vineyards	1,180
3. Other crops	96,000
Contingencies	10,320
	119,700

SUPERPHOSPHATE RATIONING MACHINERY.

Throughout Australia it was decided that priority crops should receive their normal dressings, which would be the first call on Australian stocks. In consequence, those States growing a considerable acreage of priority crops received a larger share of the Australian quota than the others. After deducting the estimated requirements for priority crops, the remaining superphosphate was distributed pro rata among the States, on the basis of the sales for the non-priority crops in 1939-40. For 1942-43, the Western Australian share was 26.36 per cent. of the Australian quota for non-priority crops.

In Western Australia, the following principles underlie the machinery used in superphosphate rationing:

1. The fertiliser available should be utilised not only to return the maximum of the various agricultural products but also that those products required for war purposes should receive utmost consideration. This amounted to an extension of the Commonwealth principle of priority crops.

2. That the great economic importance of wheat production in Western Australia should be borne in mind.

3. The complication introduced in Western Australia by reason of the compulsory reduction in wheat acreage, with compensation, together with the considerable reduction in acreage of a voluntary nature, and the States undertaking to limit the wheat crop to a harvest of 22 million bushels, be taken into account.

4. On the basis of experiments, indicating that under normal seasonal conditions, crops in the higher rainfall areas would show a greater relative depression in yield, owing to reduced supplies of superphosphate, adjustment according to rainfall is justified.

5. That provided wheat growing was confined to—

   (a) the heavier types of soils most suitable for wheat growing; and

   (b) old land which has been well cultivated and has received liberal applications of superphosphate in the past,

   it could be expected that at least a 90 per cent. crop would result in a normal season, should the superphosphate application be reduced to 40 lbs. per acre.

On the basis of the above principles, the superphosphate requirements of other crops were fully examined, and a rate of superphosphate per acre allotted, to effect full utilisation of the total quota for the State. To give effect to this, farmers were requested to supply the Department of Agriculture with particulars regarding their cropping programmes, in order that their ration of superphosphate could be decided.

The details for 1942-43 may be taken to illustrate the method used in computing quotas for farmers in Western Australia under superphosphate rationing. For priority crops on the Commonwealth list, Table II. indicates the estimated acreage involved and the ration of superphosphate allowed:

TABLE II.

Crop.	Estimated Area.	Superphosphate Ration Rate per Acre.
	acres.	cwts.
Potatoes	7,000	15
Vegetables	8,000	15
Vegetable Seeds	40	15
Blue Boiler Peas	2,000	2
Navy Beans	100	3
Berry Fruits	50	4
Flax...	9,000	2
Tobacco	1,700	10

It was estimated that these crops would require 12,200 tons of superphosphate.

In subsequent years, a measure of priority was accorded crops and pastures for dairying. In 1943-44, dairy farmers were allowed 126 lbs. of superphosphate for each 100 lbs. of butter fat delivered at a factory, or 250 gallons of whole milk supplied. This supplement was increased from 126 lbs. to 150 lbs. in 1944-45 and 1945-46.

For orchards and vineyards, the rates per acre allocated have varied from year to year, as shown in Table III.

TABLE III.

Variety.	1942–43.	1943–44.	1944–45.	1945–46.
	cwt.	cwt.	cwt.	cwt.
Citrus	2·0	2·0	3·0	3·0
Dried Vine Fruits ...	1·5	1·5	2·25	3·0
Wine and Fresh Grapes ...	1·0	1·0	1·5	3·0
All others	1·0	1·0	1·5	3·0

The allocation for non-priority crops for 1942-43 represented only 40 per cent. of normal usage. This occasioned a severe cut in the superphosphate available and allocations were made according to the schedule in Table IV.

TABLE IV.

Crop.	Acres (Estimated).	Dressing per acre under Scheme.	Estimated Tonnage Utilised.
		cwt.	
Irrigated—			
Pastures	9,500	2	950
Fodder	5,000	2	500
Pasture—		lb.	
Over 25 in. rainfall	800,000	80	28,571
Under 25 in.	400,000	50	8,932
Cereal Fodder—			
Oats	305,000		
Barley	32,000	50	7,813
Wheat	13,000		
Peas, beans, rape, roots, etc. ...	34,000	50	760
Cereal Hay—			
Wheaten	167,000	50	3,723
Oaten	213,000		4,759
Cereals—			
Wheat	1,750,000		31,250
Oats	400,000	40	7,143
Barley and Rye	50,000		893
Linseed	200	50	5
Total	...	...	95,999

In subsequent years, similar principles were followed and need not be detailed.

ADMINISTRATION.

On account of the changes in agricultural activities on many farms due to a variety of causes, many arising out of the war, it was decided to ration the superphosphate quota for Western Australia on the basis of the actual cropping programme planned by each farmer.

(a) Every farmer was required to submit an application for a permit to purchase superphosphate. He was supplied with a suitable form on which to set out his cropping programme in acres for each crop which he planned to grow.

(b) This applicaion form was obtainable from all agents and was received either by the agent or manufacturer and forwarded to the Rationing Office. The agent or manufacturer was able to advise the farmer regarding the principles involved in the rationing scheme and the information required on the application form.

(c) The application form was checked at the Rationing Office in Perth. The amount of superphosphate required on the cropping programme submitted was computed and this total compared with the quota to which the farmer would be entitled based on a percentage of his purchases in previous years. Base years selected for this purpose have been 1939-40, covering pre-war conditions, and 1941-42 covering the first year under which superphosphate rationing had been carried out.

(d) Should the programme submitted involve a greater amount of superphosphate than the maximum of his quota on the basis of previous records, the permit was limited to the maximum which was either 50 per cent. of the 1939-40 purchase or 66 per cent. of the 1941-42 purchase. It was expected that additional supplies might be available from the contingency pool.

(e) Following consideration of the application, permits were issued and could be lodged with any agent together with an order for the fertiliser which could be purchased, in one or several lots, at any time prior to June 30.

(f) While the superphosphate granted was calculated on the rate permitted per acre, the Department was unable to ensure that the fertiliser was used exactly as the farmer originally planned, but he was expected to work in reasonable conformity with the programme which he originally submitted.

RATIONING IN SUBSEQUENT YEARS.

The following notes may be of interest with respect to fertiliser rationing in subsequent years:—

1943-44: The State allocation for 1943-44 was reduced to 109,281 tons, owing to the diversion of extra superphosphate to dairy farms, in view of the increasing importance of dairy produce in the war effort. States with large dairy industries benefited greatly from this policy. In consequence, the rates of superphosphate for grain crops and pastures were reduced by 25 per cent. in all cases, except for topdressing of pastures in areas under 25 inch rainfall, where the reduction was 10 per cent. Dairy pastures benefited from the supplementary allocation of 126 lbs. of superphosphate for each 100 lbs. of butter fat or 250 gallons of whole milk supplied to the industry. This supplement was designed to bring dairy farmers to 75 per cent. of their 1939-40 usage of superphosphate.

Non-priority crops, generally, were reduced to about one-third of their 1939-40 usage. Fortunately, the State quota was increased by 10,523 tons later in the year, as a result of an increase in the Commonwealth quota. An additional 1,600 tons of phosphate from Pelsart Island, utilised at the Geraldton works, resulted in the total available to Western Australia being increased to 121,404 tons. The additional superphosphate was used to meet unforeseen contingencies, and as a supplement of 7½ lbs. of superphosphate per acre for the licensed area of wheat and of malting barley.

1944-45: The Western Australian allocation in 1944-45 was 195,755 tons. Rationing was simplified by allowing an increase of 55 per cent. on all quotas for non-priority crops, and a 20 per cent. increase in the dairy supplement. The submission of cropping and top-dressing programmes was not required. Permits were issued, but in general, the machinery for rationing was very much simplified.

Owing to the unexpectedly low demands on the contingency pool, and due to a number of farmers not requiring their full quotas, a surplus of 12,000 tons remained for distribution towards the end of the year, and this was made available as a special issue to farmers licensed to crop more than five-sixths of their basic area of wheat, and for the renovation of pastures.

1945-46: The allocation to Western Australia for 1945-46 is 265,818 tons, together with a portion of the 70,000 tons set aside by the Commonwealth for allocation to ex-servicemen. Basic quotas were again increased by 55 per cent., but no increase was made in the dairy supplement. Farmers of non-priority crops will find that their quota represents over 90 per cent. of their 1939-40 purchases. Due to the dairy supplement, the quota for dairymen is in excess of the 1939-40 tonnage, but approximately equal in P_2O_5 content.

Table V. shows the rate of superphosphate per acre allowed for the various non-priority crops during the rationing period:—

Table V.

RATE PER ACRE FOR NON-PRIORITY CROPS.

Crop.	1942–43.	1943–44.	1944–45.	1945–46.
	lb.	lb.	lb.	lb.
Wheat	40	37·5	58	90
Oats	40	30	47	73
Barley	40	30	47	73
Rye	40	30	47	73
Hay	50	45	70	109
Green Fodder	50	45	70	109
Pasture (Rainfall Under 25 in.)	50	45	70	109
Pasture (Rainfall over 25 in.)	80	60	93	144

SUPERPHOSPHATE STATISTICS.

The rationing of superphosphate was necessarily based on statistics. These were obtained largely from the fertiliser manufacturers and in some cases from the farmer himself. In the course of four years of fertiliser rationing, a valuable body of statistics has been accumulated. As it is likely that this information will be of considerable interest to the manufacturing and distributing industries, as well as to farmers, it has been analysed and compiled for publication in this report.

Estimates were made of the usage of superphosphate for the main crops of the State for 1939-40, and for the four years of rationing. This information is given in Table VI.

TABLE VI.

ESTIMATED SUPERPHOSPHATE USAGE BY CROPS IN W.A.

Crops.	1939–40.	1942–43.	1943–44.	1944–45.	1945–46.
	tons.	tons.	tons.	tons.	tons.
Potatoes	4,250	6,000	5,250	10,500	8,000
Vegetables	3,900	5,000	6,750	6,982	6,000
Navy Beans	...	...	7	...	...
Blue Peas	...	200	200	...	...
Vegetable Seeds	...	100	113	143	150
Berry Fruits	20	...	10	2	...
Flax	...	900	1,000	1,000	1,000
Tobacco	500	750	850	700	250
Hops	15	20	15	20	20
Irrigated and Dairy Pastures	40,300	29,500	30,225	40,300	55,000
Other Pasture	28,830	9,000	16,500	25,600	39,500
Cereal Grain—Wheat	129,265	31,250	31,900	60,000	93,000
Cereal Grain—Oats	19,606	7,500	6,100	9,500	14,500
Cereal Grain—Barley	3,600	1,000	870	1,300	2,000
Cereal Hay and Green Feed	30,529	19,000	15,200	24,700	38,000
Maize Grain and Feed	230	300	200	465	400
Rye	100	100	40	60	100
All Citrus	420	400	400	620	620
Vine and Tree Fruits for Drying	350	300	450	700	900
Fresh and Wine Grapes	330	300	225	350	620
Bananas	60	75	75	75	75
Pome and all other Fresh Fruits	2,450	400	850	1,320	2,510
Green Forage	1,600	500	565	880	1,400
Grass and Small Agricultural Seeds	250	200	150	235	250
Mangels	40	...	10	15	...
Field Peas	600	200	105	160	150
Establishment of Lucerne	220	100	70	110	100
Peanuts, Passion Fruits	60	60	40	60	60
Aerodromes	...	...	...	150	150
Total	267,525	113,155	118,170	185,947	264,755
Adjustment of Anomalies	...	6,545	3,234	...	1,063
Contingencies Pool and Overdrawal, 1944	...	...	...	9,808	...
	267,525	119,700	121,404	195,755	265,818

In order to illustrate the position, the statistics for the years 1939-40 (which were adopted as the base throughout the Commonwealth) and 1944-45 were subjected to analysis. In this analysis the superphosphate purchases, or quotas to which farmers have been entitled, have been grouped into various tonnage ranges. Up to quotas of 10 tons, single ton units have been adopted as the range; for higher tonnages the groups have been extended, as will be observed from the tables.

Table VII. shows the number of farmers whose quotas fall within the various ranges. This information is also illustrated by the graph in Fig. 1. The height of the columns for each range indicates the number of farmers whose quotas fall within the tonnage range. The effect of superphosphate shortage and rationing in increasing the number of farmers in the lower ranges is well illustrated by this graph.

Table VII.

Quota Range.	Estimated Number of Quotas in Quota Range.		Estimated Number of Quotas in each Single Ton Category.	
	1939–40.	1944–45.	1939–40.	1944–45.
	tons.	tons.	tons.	tons.
Under 1 ton	702	790	702	790
1½ tons— 2 tons	291	680	291	680
2½ tons— 3 tons	358	699	358	699
3½ tons— 4 tons	498	702	498	702
4½ tons— 5 tons	490	718	490	718
5½ tons— 6 tons	747	748	747	748
6½ tons— 7 tons	344	869	344	869
7½ tons— 8 tons	508	1,092	508	1,092
8½ tons— 9 tons	222	1,271	222	1,271
9½ tons— 10 tons	837	714	837	714
10½ tons— 12 tons	829	1,406	415	703
12½ tons— 15 tons	1,054	1,537	351	512
15½ tons— 20 tons	1,972	1,317	394	268
20½ tons— 25 tons	1,113	748	226	145
25½ tons— 30 tons	929	389	186	78
30½ tons— 40 tons	844	337	84	34
40½ tons— 50 tons	468	156	46	15
50½ tons— 60 tons	233	77	23	8
60½ tons— 80 tons	206	67	10	3
80½ tons—100 tons	89	23	4	1
Over 100 tons	109	21	...	...

Table VIII.

Quota Range.	Estimated Tonnage of Superphosphate Purchased in Quota Range.		Estimated Tonnage of Quotas in each Single Ton Category.	
	1939–40.	1944–45.	1939–40.	1944–45.
	tons.	tons.	tons.	tons.
Under 1 ton	51	395	51	395
1½ tons— 2 tons	510	1,190	510	1,190
2½ tons— 3 tons	985	1,925	985	1,925
3½ tons— 4 tons	1,870	2,630	1,870	2,630
4½ tons— 5 tons	2,330	3,410	2,330	3,410
5½ tons— 6 tons	4,290	4,300	4,290	4,300
6½ tons— 7 tons	2,320	5,870	2,320	5,870
7½ tons— 8 tons	3,940	8,460	3,940	8,460
8½ tons— 9 tons	1,943	11,130	1,943	11,130
9½ tons— 10 tons	8,160	6,960	8,160	6,960
10½ tons— 12 tons	9,320	15,800	4,660	7,900
12½ tons— 15 tons	14,480	21,100	4,826	7,033
15½ tons— 20 tons	35,000	23,400	7,000	4,680
20½ tons— 25 tons	25,350	17,040	5,070	3,408
25½ tons— 30 tons	25,800	10,800	5,160	2,160
30½ tons— 40 tons	29,700	11,870	2,970	1,187
40½ tons— 50 tons	21,600	7,050	2,160	705
50½ tons— 60 tons	12,860	4,250	1,286	425
60½ tons— 80 tons	14,420	4,680	721	234
80½ tons—100 tons	8,010	2,070	400	103
Over 100 tons	15,145	2,935	...	...

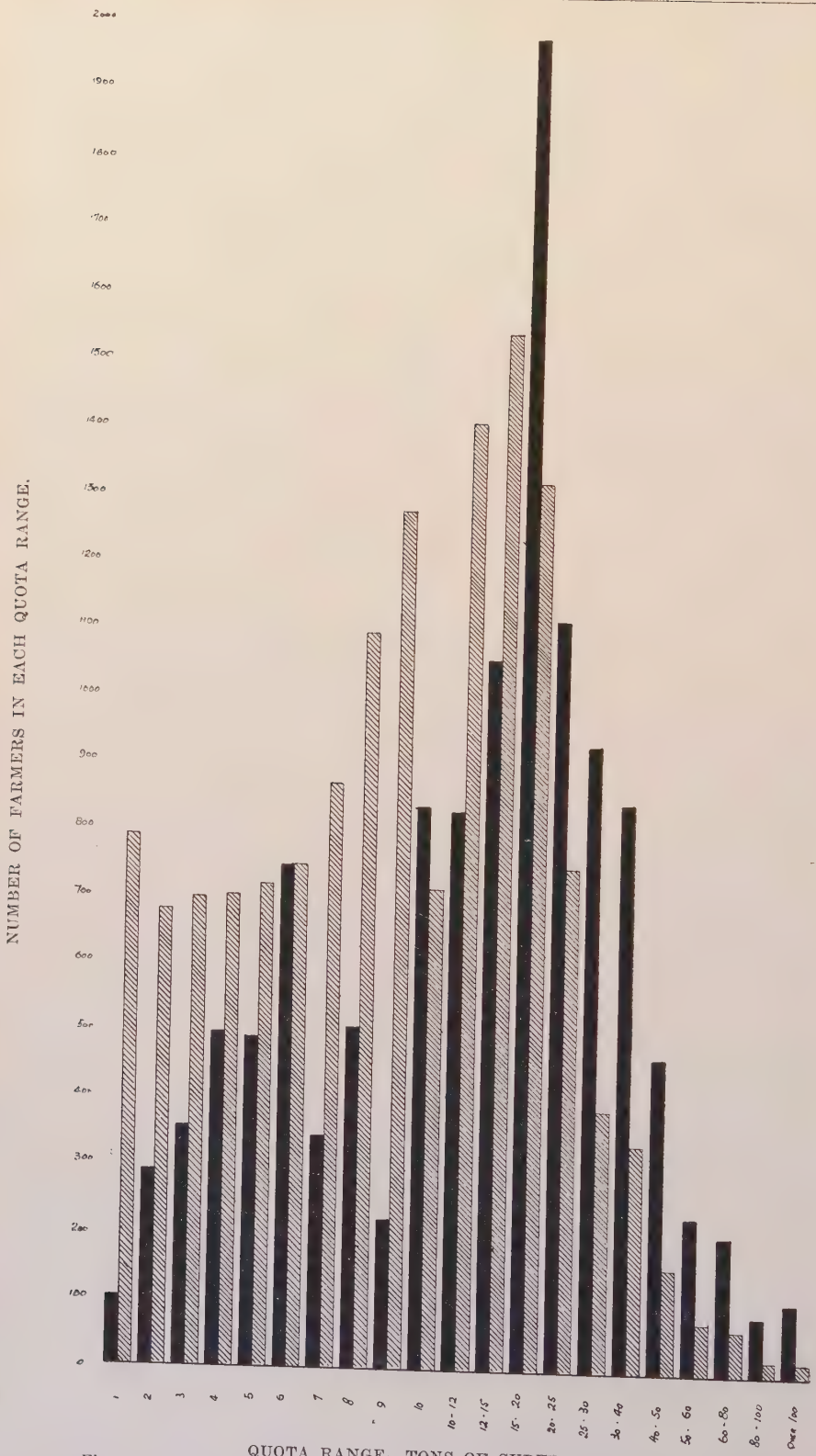


Fig. 1. Number of farmers purchasing superphosphate in each quota range.

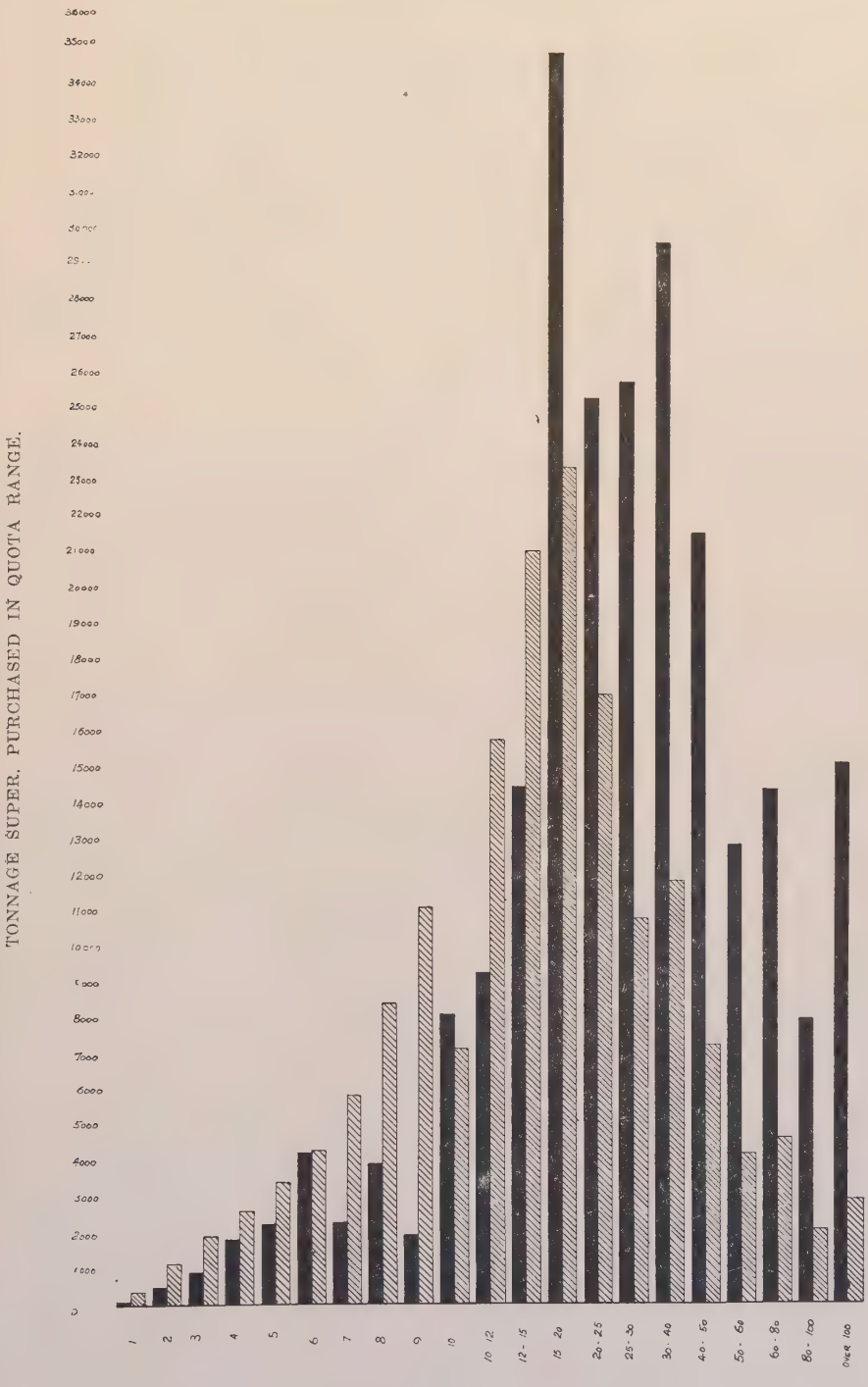


Fig. 2. Tonnage of superphosphate purchased by quota ranges.

The total amount of superphosphate purchased in each range has been estimated and the data are shown in Table VIII. This information is also illustrated by the graph in Fig. 2. The height of the columns shows the tonnage of superphosphate sold in each quota range. The solid black areas indicate 1939-40, and the hatched areas, 1944-45. Again, the shift in the tonnage to the lower ranges in 1944-45, as compared with 1939-40, is illustrated by the graph. It is of interest that the maximum tonnage in a single ton range was purchased by farmers ordering between 9½ and 10 tons. This category absorbed over 8,000 tons of superphosphate in 1939-40. In 1944-45, the 8½-9 ton range absorbed over 11,000 tons, and higher ranges were considerably smaller than for 1939-40.

The Rationing of Nitrogenous Fertilisers in Western Australia.

L. J. H. TEAKLE and D. J. COLLINS.

THE wartime shortages of nitrogenous fertilisers and difficulties in obtaining supplies from overseas, rendered it necessary to bring these commodities under National Security Regulations, in order that their distribution to users could be controlled and supplies directed to industries of greatest importance in the war effort and in the provision of food for the nation. The regulations controlling nitrogenous fertilisers were gazetted on 1st August, 1942.

The bulk of Australia's requirements of nitrogenous fertilisers prior to the war was imported. Two-thirds of the sulphate of ammonia used came from the United Kingdom, and nitrate of soda was obtained from Chile, in South America. Local production of sulphate of ammonia was obtained largely from the coking furnaces.

SULPHATE OF AMMONIA.

In the early stages of the war, it was possible to obtain shipments of sulphate of ammonia from Canada, but as the situation became more difficult, Australia had to rely almost entirely on local production. Demands were greatly enhanced, owing to the requirements for munitions manufacture and the vastly increased areas sown to priority crops, for which nitrogen is a vital fertiliser.

Prior to the war, the Australian consumption of sulphate of ammonia was approximately 52,000 tons, of which 17,000 tons was produced locally. As a result of improved recovery by the end of 1941, Commonwealth production had increased to approximately 25,000 tons. This shortage, in view of the greatly enhanced demand, rendered it necessary to control distribution.

All available supplies of sulphate of ammonia were brought under control on 3rd September, 1941, under a distribution scheme operated through Nitrogen Fertilisers Ltd., which handled the whole of the supplies on behalf of the Commonwealth Government. At this time, merchants and distributors had been forced

by a shortage of supplies to limit clients to 50 per cent. of the normal amount purchased. By the end of October, 1941, this form of rationing had broken down and stocks had reached such a low level that it was decided to reserve supplies of sulphate of ammonia not required for industrial purposes to be used in mixed fertilisers.

Under National Security Regulations, from 3rd August, 1942, the rationing of sulphate of ammonia, as well as nitrate of soda, came under the control of the Departments of Agriculture in each State. These fertilisers could be purchased in amounts in excess of 7 lbs. only with the permission of the permanent head of the State Department of Agriculture. The preparation of fertiliser mixtures by manufacturers was brought under the authority of the Departments of Agriculture, and in Western Australia, in the 1942-43 season, was limited to potato manure C, tobacco and tomato manures and potato manure D which included nitrate of soda instead of sulphate of ammonia. These were available only for potato, vegetable and tobacco crops until 1945-46.

Table I. sets out the mixed fertilisers available under the ratioinng scheme, together with the price and guaranteed analysis. A full table of registered fertilisers appeared in the December Journal of Agriculture.

Table I.

TABLE OF GUARANTEED ANALYSES.

Fertiliser.	Cash Price.	Nitrogen.	Potash.	Phosphoric Acid.				Remarks.
				W.S.	C.S.	A.S.	Total.	
	£ s. d.							
Potato Manure "C" or No. 2*	7 17 10	3·00	....	11·50	2·00	1·50	15·00	To 31st July, 1945.
Potato Manure "C" or No. 2*	8 4 8	3·50	....	11·00	2·00	1·50	14·50	As from 1st August, 1945.
Potato Manure "A" (C.S.M.L.)	9 15 7	2·50	5·00	10·00	1·75	1·25	13·00	C.S.M.L. ceased making "A" on 15th March, 1945.
Potato Manure "A" (CRESCO)	9 15 7	2·50	5·00	10·00	2·00	1·00	13·00	
Potato Manure "A2"	9 0 1	2·23	4·45	8·89	1·56	1·11	11·56	
Potato Manure "AM"	9 15 7	2·50	5·00	11·00	1·75	1·25	14·00	
Tomato Manure (C.S.M.L. only)	11 12 3	3·50	8·00	9·00	1·50	1·00	11·50	
Tobacco Fertiliser No. 5 (C.S.M.L. only)	8 19 4	2·80	2·50	10·87	1·88	1·25	14·00	

* The Nitrogen content of Potato Manure "C" was increased from 3·00 per cent. to 3·50 per cent. on 1st August, 1945.

The policy of strict rationing of sulphate of ammonia has been retained throughout the war period and the regulations are still being enforced. In spite of the controls, temporary shortages, largely due to transport difficulties delaying the arrival of supplies, caused some dislocation in the vegetable and potato industries, but as a rule, growers were able to secure their supplies in accordance with the ration provided for the various crops.

The supply position with respect to sulphate of ammonia improved in 1945-46 and a small tonnage has been released at the rate of 1 cwt. per acre for the dressing of citrus and dried fruit. The supply and distribution of sulphate of ammonia since 1939-40 are shown in Table II.

Table II.

SULPHATE OF AMMONIA.

Its Supply and Distribution.

Year.	Sold as Such.	Sold in Mixtures.	Total.
	tons.	tons.	tons.
1938–1939	...	...	4,020
1939–1940	395	2,366	2,761
1940–1941	132	1,864	1,996
1941–1942	43	1,490	1,533
1942–1943	34	1,229	1,263
1943–1944	...	1,374	1,374
1944–1945	368	1,969	2,337
1945–1946 (estimated)	1,125	2,000	3,125

NITRATE OF SODA.

Prior to the war, very little nitrate of soda was used in Western Australia for agricultural purposes. However, the acute shortage of sulphate of ammonia resulted in a demand for nitrate of soda and during the war this fertiliser became the only nitrogenous material available for topdressing of potato and vegetable crops, for horticultural purposes and for growing summer fodder crops.

In 1942-43 nitrate of soda was in such short supply that it could not be made available for orchardists other than citrus growers. However, importations improved, and in 1943-44 it was made available to all orchardists, the allocation being made on a scale according to the type of fruit grown. The allocation was improved in 1944-45, and has been maintained for 1945-46.

Table III. shows the scale of allocations for the various types of orchards.

Table III.

THE ALLOCATION OF NITRATE OF SODA FOR ORCHARDS.

Type of Orchard.	1942–43.	1943–44.	1944–45.	1945–46.
		cwt. per acre.	cwt. per acre.	cwt. per acre.
Citrus	small allocation	3	3	3
Fresh and Wine Grapes ...	*nil*	2	3	3
Dried Vine Grapes ...	*nil*	2	3	3
Other Fruits	*nil*	2	3	3

For topdressing, vegetables were allowed 4 cwts. per acre, and potato crops 2 cwts. per acre. Nitrate of soda was also available at the rate of 1 cwt. per acre for the growing of approved summer fodder crops for dairy purposes, in order to meet the increased demand for dairy products.

As with sulphate of ammonia, shortages of nitrate of soda occurred from time to time as a result of unsatisfactory shipping conditions. During April and May, 1945, sulphate of ammonia was substituted for nitrate of soda for top dressing vegetable crops, and it proved necessary during the summer months of 1945-46 to restrict the allocation of nitrate of soda to topdressing of vegetable and summer fodder crops.

Table IV. shows the tonnages of nitrate of soda sold during the war years.

TABLE IV.
NITRATE OF SODA.
Its Use and Distribution.

Year.	Sold as Such.	Sold in Mixtures.	Total.
	tons.	tons.	tons.
1939–1940	24	57	81
1940–1941	21	39	60
1941–1942	8	53	61
1942–1943	660	55	715
1943–1944	2,500	216	2,716
1944–1945	1,718	31	1,749
1945–1946 (estimated)	2,101	50	2,151

The Rationing of Blood and Bone Fertiliser in Western Australia.

By L. J. H. TEAKLE and D. S. HORWOOD.

MANY market gardeners and vignerons in Western Australia regard blood and bone, bone dust and similar fertilisers of animal origin as the most satisfactory basis for their manurial practice. The so called artificial fertilisers such as superphosphate, sulphate of ammonia, etc, are preferred as supplements to the more popular animal fertilisers. These animal fertilisers have been used largely for the growing of vegetables in the metropolitan areas. It is estimated that prior to the war about two-thirds of the blood and bone supplies were absorbed in this industry. The rest was used largely for the growing of vines and for potatoes.

In pre-war days vegetable growers used large applications per acre, common dressings ranging from 20 cwts. to 30 cwts. for a crop. In addition to this liberal treatment, some used extra applications as topdressings to force growth. Prior to the war growers in Western Australia used about 5,000 tons of these animal fertilisers per annum and the demand was increasing.

When the tide of war forced Australia to increase production of important foodstuffs to the maximum, special attention was devoted to the so-called priority crops, of which vegetables were high in the list. The drive for increased vegetable production commenced in March, 1942, when the first targets for increased production were placed before growers. The targets for Western Australia in successive years are shown in Table I.

TABLE I.
TARGETS FOR VEGETABLES AND POTATOES.

	1939–40.	1942–43.	1943–44.	1944–45.
	acres.	acres.	acres.	acres.
Vegetables	4,282	7,000	10,400	9,000
Potatoes	5,676	7,000	14,000	10,020

The success of this drive for production depended on a number of factors, of which not the least important was the capacity to supply the grower with his idea of fertiliser requirements. In Western Australia growers usually adjust the acreage planted to the fertiliser available, as they are convinced that economy in fertilisers means liability to serious reduction in crop yield and involves risk of failure.

The extra acreage of vegetables to be planted meant an increase in the demand for blood and bone fertiliser, and, coupled with this, was a serious falling off in the supply. Imports were halved and local production dropped about 20 per cent. The fall in local production was due largely to the closing of the Wyndham Meatworks, which produced normally about a thousand tons per annum. This loss was slightly offset by increased metropolitan production.

Table II. gives the supply position with respect to animal fertilisers over a number of years.

Table II.

SUPPLY OF ANIMAL FERTILISERS FROM 1935 TO 1945.

(Long Tons.)

	1935–36.	1936–37.	1937–38.	1938–39.	1939–40.	1940–41.	1941–42.	1942–43.	1943–44.	1944–45.
Local Production	2,006	2,358	2,760	2,893	2,816	2,663	2,289	2,289	2,357	2,079
Imports	1,666	2,289	1,586	1,930	1,702	2,508	2,410	1,110	1,533	1,021
Total	3,672	4,647	4,346	4,823	4,518	5,171	4,699	3,399	3,890	3,100

Accompanying the demand commencing in early 1942 for increased production and the increased fertiliser requirements, were the mounting difficulties in securing supplies from the Eastern States. In the period of shortage many growers were unable to secure their requirements. The situation caused considerable concern amongst traders and the attention of the Department of Agriculture was drawn to the problem. As a result, a voluntary rationing scheme was introduced in April, 1942. Animal fertilisers were reserved for vegetable growing and the merchants pledged themselves to sell only to bona fide market gardeners. In view of the importance of vegetable seed production in 1942, a special priority was accorded this industry and in May, 1942, a permit system was introduced to ensure a supply of blood and bone to producers of vegetable seed.

Meanwhile, the difficulties of importers increased. Some Eastern States exporters decided to relinquish interstate trade for their local markets. Pending the organisation of a Commonwealth-wide system for the distribution of animal fertilisers, it was necessary to devise a rationing scheme in Western Australia to ensure that vegetable growers would share in the supplies as equitably as possible. The voluntary scheme had failed to meet these requirements.

To meet the conditions a draft proposal was drawn up by the Department of Agriculture and placed before the distributors in September, 1942, as a basis for machinery to ration animal fertilisers within the established trade organisation. The proposal was supported by the Market Gardeners' Association. Arising out of the discussions between the Department of Agriculture, the merchants and the market gardeners, a rationing scheme was decided upon and adopted in December, 1942.

This scheme was based upon the following principles:—

1. Animal fertilisers would be restricted to vegetable and potato crops and to the production of vegetable seeds.

2. Growers requiring animal fertilisers for these crops should submit an application to the Department of Agriculture, giving particulars regarding the crops to be grown and the acreages involved.
3. The application would be checked and endorsed by an officer of the Department of Agriculture engaged in advisory and inspectorial work in the vegetable growing districts.
4. The Fertiliser Rationing Office would issue a permit for the supply of animal fertiliser, according to a scale of allocations for the crops, covering a period of three months.
5. At first the permit was issued to the grower and his agent was advised by a duplicate. Supply was obtained by presenting the permit to an agent who would endorse it with the date and quantity delivered. Unfortunately, this method involved difficulties and in 1943 arrangements were made to issue permits to the nominated agent. The grower was advised of the quantity of fertiliser to which he was entitled and was expected to procure it from the agent holding the permit.

Fertiliser Control Regulations under the National Security Act, to include animal fertilisers and feeding meals, were gazetted by the Commonwealth Government on August 31st, 1942. Under these regulations the export of animal fertiliser from Australia was prohibited and the control of sales within the States vested in the permanent heads of the Departments of Agriculture.

The Australian production was examined by the Agricultural Council and it was arranged that representatives of the Departments of Agriculture of the several States concerned should confer and agree upon an equitable distribution of the manufactured product. In October, 1942, agreement was reached whereby purchases during the two preceding years should constitute a base for calculating the quota to be released to the importing States. The chief exporting States—New South Wales and Victoria—agreed to facilitate the supply of animal fertiliser on this basis.

The Victorian Department of Agriculture established a formal rationing scheme and each year determined a quota which it was hoped could be supplied to the importing States. On the basis of the purchases in the base years, the Victorian quota for Western Australia amounted to 12.8 per cent. of the total Victorian production. New South Wales agreed to facilitate exports, but owing to shipping and other difficulties, it proved impossible to export regular supplies.

During the first seven months of rationing, animal fertiliser was allocated to growers at a flat rate of 10 cwts. per acre for all vegetables. However, with the increasing acreage sown to vegetables, this ration proved too liberal in relation to supplies and had to be reduced. A new scale was adopted and vegetable crops were divided into three categories, only two of which were eligible for a ration of animal fertiliser.

Schedule 1—*Ration* 6 *cwts. per acre.*

Bananas	Cauliflowers
Potatoes	Lettuce
Cabbages	Rhubarb
Tomatoes	Celery
Silver Beet	Runner Beans
Onions	French Beans
Parsnips	Herbs
Carrots	

Schedule 2—*Ration* 3 *cwts. per acre.*

Green Peas	Spinach
Beetroot	Sweet Potatoes
Leeks	Swedes
Turnips	

Schedule 3.

All other vegetables.

Rationing proceeded smoothly during 1942-43, although permits issued were slightly in excess of the supplies, as shown by the following figures:—

Supplies for Year Ending 30*th June,* 1943.

	Tons.
Imports	1,110
Local Production	2,289
Permits Issued	3,512

The same general rationing scheme operated in subsequent years, and the demand was equated to the supply satisfactorily until the 1944-45 season, when the tonnage available was the lowest for ten years.

The supply position further deteriorated and in 1945-46 it proved necessary to reduce the allocations. Commencing on October 1st, 1945, the allocations were fixed at 5 cwts. per acre for crops in Schedule 1 and 2½ cwts. per acre for crops in Schedule 2. As the shortage persisted, the allocations were further reduced as from 1st January, 1946, to 3 cwts. and 1½ cwts. per acre, respectively, for Schdules 1 and 2. By this means it is hoped that a small reserve will be built up to meet the increased demands for animal fertiliser during the winter months.

The re-opening of the Wyndham Meatworks in 1945 relieved the situation slightly, with a production of 328 tons. It is hoped that during the coming year this production may be very greatly increased.

DISCUSSION.

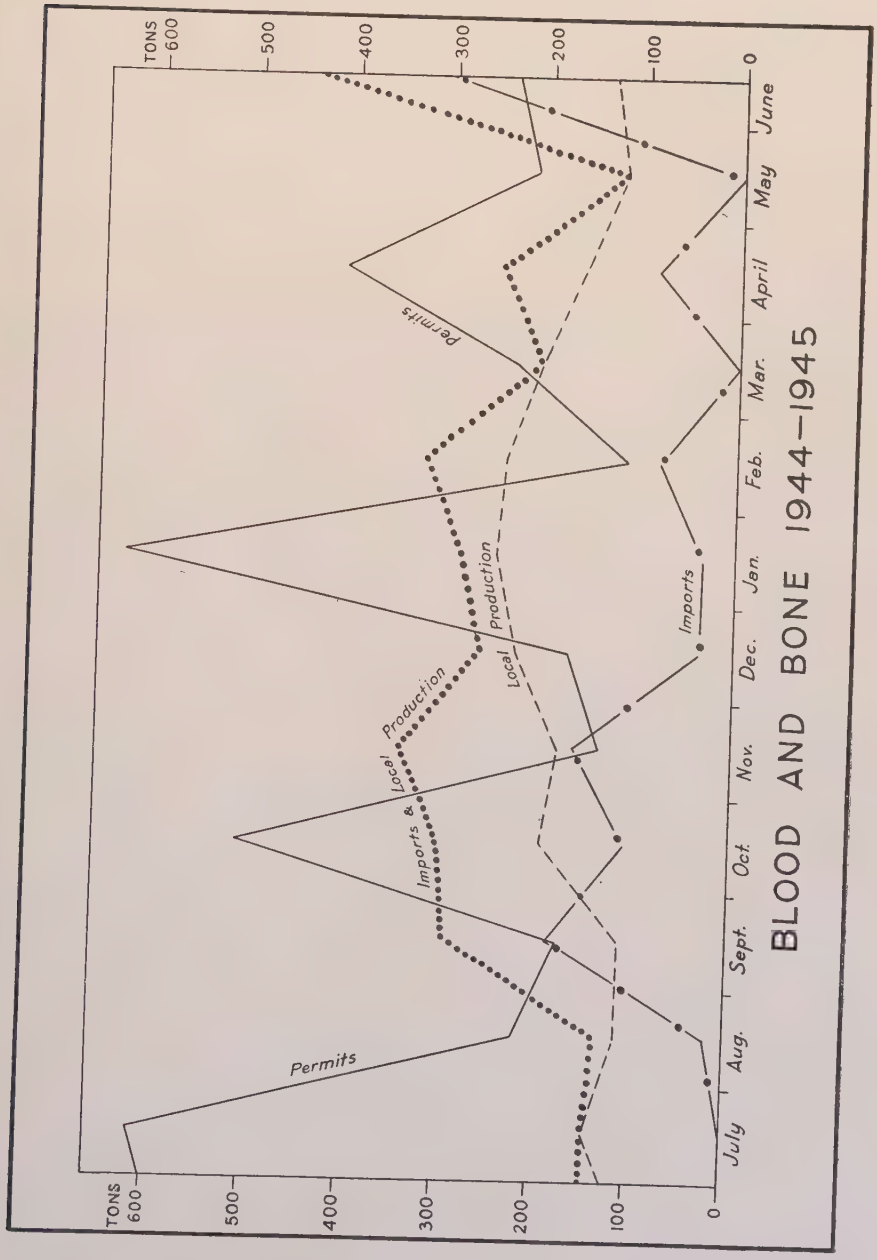
The problems encountered in the rationing of animal fertiliser are illustrated by the accompanying diagram, which sets out the salient features for the year 1944-45. It may be noted that the permits issued show two main peaks and two minor peaks. The quarters of heaviest demand are January-March and July-September. Against this, the supply is far from constant. Local production reaches its highest point in January, with fairly even gradients on either side. Unfortunately, the imports are subject to violent fluctuations. During 1944-45 there were no imports for three months; for four months the importation was under 100 tons; while for the month of June it rose to over 300 tons.

It can be understood that these variations in supply and demand have rendered rationing difficult and have meant that growers have at times been unable to secure their quotas of animal fertiliser when required.

Everything possible was done to maintain an even supply of animal fertiliser by representations to the shipping authorities and the exporters in the Eastern States. War-time conditions, coupled with unprecedented droughts, were responsible for the difficulties. It is pleasing to record that the heartiest co-operation was received from the Departments of Agriculture in Victoria and New South Wales in efforts to relieve the position.

Now that the war is over, it is anticipated that the acreages of vegetable crops planted will decrease and the demand will ease. It is not expected, however, that imports from the Eastern States will reach pre-war figures as there is evidence

of a growing realisation of the value of animal fertilisers throughout Australia. There seems no alternative to growers making greater use of artificial fertilisers in the production of vegetable crops, and experiments carried out by the Department of Agriculture indicate that, under suitable systems of management, and maintenance of the soil organic matter, animal fertilisers can be replaced by artificials without loss of yield or quality.



Rationing of Feeding Meals, 1944-45.

By L. J. H. TEAKLE and D. S. HORWOOD.

A COMPREHENSIVE account of the rationing of feeding meals up to June 30, 1944, was published by Teakle and Needham in the September, 1944, issue of this Journal. The present report covers operations during 1944-45 and gives later statistics showing the position during a very difficult year. As in previous years, basal allocations were made to growers in accordance with the number of stock being fed and monthly rations were adjusted to the anticipated available tonnage. Rationing was based on an expectation of 67 tons of feeding meal per month for pigs and 156 tons for poultry.

Statistics showing the supplies of meatmeal available to the State during the six years ending 30th June, 1945, are given in Table I. The weights are expressed in long tons and an error in the figures published in the earlier report, arising out of the partial use of short tons in the industry has been corrected.

TABLE I.

(Long Tons.)

Year.	Imports.	Local Production.	Total.
1939–40	1,950	523	2,473
1940–41	2,292	761	3,053
1941–42	1,417	606	2,023
1942–43	1,436	744	2,180
1943–44	1,669	988	2,657
1944–45	1,169	1,100	2,269

Local production during the year improved to the extent of 150 tons net by the manufacture of a feeding meal from crude pig offal. This meal has been used largely for pig feeding.

For 1944-45 the allocation of meatmeal to permit-holders amounted to 1,839 tons for poultry and 805 tons for pigs. In addition, 54 tons were sold in mashes outside the permit system, bringing the total to 2,698 tons. Against this, the supply was only 2,269 tons. Although the supply position was difficult through much of the year, the ration was not reduced until 1st July, 1945, owing to the continued expectation of substantial imports from Eastern States' sources as indicated by the allotted import quotas. However, the severe drought conditions, combined with shipping difficulties, resulted in imports of only 1,169 tons, of the expected 1,700 tons, in spite of every assistance from officers of the Departments of Agriculture of Victoria and New South Wales.

Monthly statistics showing allocations and supplies are given in Table II. Fig. 1 illustrates the position and may be studied in conjunction with the data set out in Table II.

It will be seen from this data that imports were below the expectation of 140 tons in every month of the year except August and April, when 186 tons and 302 tons, respectively, were obtained from the Eastern States. Months with conspicuously low imports were March (zero), September (27 tons), July (51 tons).

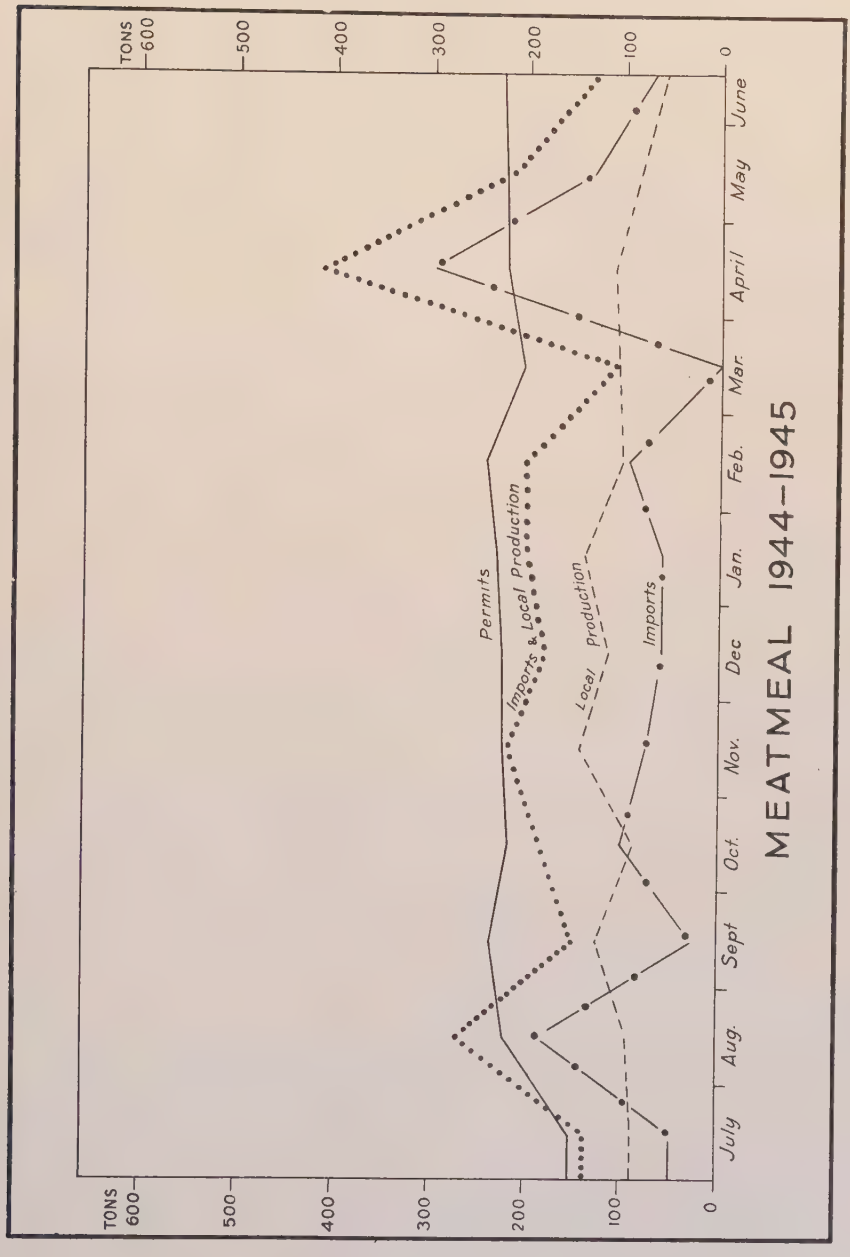

MEATMEAL 1944–1945
TONS
600
500
400
300
200
100
0
July
Aug.
Sept
Oct.
Nov.
Dec
Jan.
Feb.
Mar.
April
May
June
Permits
Imports & Local Production
Local Production
Imports

TABLE II.

SUPPLIES OF FEEDING MEALS AND MONTHLY ISSUES OF PERMITS 1944–45.

(Long Tons.)

Month.	Pigs.			Poultry.			Supplies.			
	Basal Allocation.	Per cent. of Reduction.	Purchases Allowed.	Basal Allocation.	Per cent. of Reduction.	Purchases Allowed.	Total Purchases Allowed.	Imports.	*Local Production.	Total.
1944.	tons.		tons.	tons.		tons.	tons.	tons.	tons.	tons.
July	40	10	36	133	10	120	156	51	89	140
August	74	10	67	172	10	155	222	186	96	282
September	83	10	75	183	10	165	240	27	135	162
October	89	25	67	191	20	153	220	101	88	189
November	93	25	70	195	20	156	226	78	143	221
December	93	25	70	196	20	157	227	62	118	180
1945.										
January	99	25	74	200	20	160	234	60	140	200
February	107	25	80	204	20	163	243	97	103	200
March	107	40	64	204	30	143	207	...	109	109
April	110	40	66	206	25	155	221	302	110	412
May	112	40	67	207	25	155	222	134	83	217
June	115	40	69	210	25	157	226	71	60	131
	1122	...	805	2301	...	1839	2644	1169	1274	2443
Monthly Average ...	93·5	...	67	192	...	153	...	...	...	...
Per cent. of Basal Quota	...	...	72	...	...	80	...	...	...	...

* Gross figures submitted by manufacturers; a loss of 174 tons was incurred in processing and through wastage.

The prospects for the supply of feeding meals from the Eastern States for 1945-46 are not encouraging and the ration has had to be reduced in accordance with expected supplies.

It is the purpose of the rationing scheme to ensure that, as far as possible, every user will be able to purchase his full entitlement during the period of acute shortage.

The Eradication of St. John's Wort in Western Australia.

A. L. HAMILTON, Dairy Adviser.

ST. John's Wort, a noxious weed, is native to temperate regions of Europe and Asia, where, apparently, it has not proved troublesome. However, it has been introduced into the United States of America from where stock losses have been reported, and into Australia, where it has assumed major economic importance. In New South Wales and Victoria, it is regarded as one of the most serious weeds requiring eradication, or control, and it has been reported to a lesser extent in Tasmania, South Australia and Western Australia.

The spread of this weed in this State has apparently followed the development noted in New South Wales and Victoria, in that the rate of increase in the first instance was slow. After a lapse of time the rate assumed alarming proportions, and, in the latter two States, large areas of land rapidly became infested and were rendered useless for the growth of pasture, and for cultivation. By 1931, 244,519 acres in Victoria were infested, and large sums of money are still expended annually in control. In New South Wales it is no less serious and is declared an important noxious weed in 22 shires and seven municipalities.

It is thought that St. John's Wort was introduced into this State some 50 years ago, but it was not until 1935 that prolific growth in the lower South-West was reported. The initial collection of specimens was made by the Government Botanist, Mr. C. A. Gardner in December, 1934. It was calculated, at that time, that approximately 70 acres were infested from Margaret River to Augusta, the more serious areas occurring on forestry property at Margaret River and surrounding the old mill site at Karridale. Patches of the weed were later reported at Cowaramup, seven miles north of Margaret River, at Flinder's Bay, and eastwards on a property east of the Alexandra Bridge over the Blackwood River. Small infestations have also been discovered in the Harvey area, at Holyoake, Pinjarra and between Greenbushes and Bridgetown.

It is a notable fact that practically all the infestations in the lower South-West can be traced back to the activities of the early timber trade, which established an extensive mill and headquarters at Karridale. The spread of the weed closely follows the banks and cuttings along which ran the old "tram tracks" used for hauling the timber to the mills, and in other instances, heavy infestations have been discovered on old sites which were originally horse yards and stables. From this it is assumed that the introduction of St. John's Wort to Western Australia followed the importation of horse feed and other material for the use of the mills per medium of the shipping, which, in the early days, continually used the port of Hamelin Bay.

Infested areas have subsequently been found on properties scattered throughout the Karridale district, and no doubt travelling stock have been the agency in the spread of the weed in these instances. Approximately fifteen privately held properties are affected, and in all but three cases the infestation is confined to quite small areas which are easily controlled by the landholder. This work is carried out annually in conjunction with the local road board. The main growth occurs on Crown lands, Forestry reserve and vacant Rural and Industries Bank holdings.

St. John's Wort is easily recognisable from a description of its more important features and its habit of growth. The plant (*Hypericum perforatum* var. *augustifolium*.) is a perennial with erect stems arising from a woody, creeping root system. The leaves, which are narrow and up to one inch long are arranged on opposite sides of the stem, and are marked with semi-transparent oil dots which are readily seen when the leaf is held up to the light. The flowers, which are carried in dense clusters at the apex of the stem, are bright yellow in colour, and consist of five pointed petals regularly arranged. The vivid yellow colour renders the plant most conspicuous during the flowering period. The relatively dark blue-green colour of the leaves and stems, makes detection fairly easy when growing among native grasses and pasture plants prior to flowering.

The plants grow in dense clumps and soon smother relatively strongly growing species. It is for this reason that eradication is important in this State. When eaten by stock, in quantity, the unpigmented portions of the skin of the animals

may be rendered ultra-sensitive to strong sunlight, and an inflamed and ulcerated condition of these portions becomes apparent and subsequent death may result. However, there has not been an instance of this toxic effect reported in this State to date, but there is a ample evidence of the smothering habit of growth of this plant in semi-cleared and open country. It is vigorous under conditions of semi-shade, but will not grow in heavily shaded forest country. Advantage has been taken of this fact in the Eastern States, where considerable areas of farm lands have been planted with pines to establish control.

With the reported serious spread of St. John's Wort in 1935 it was decided that immediate control measures should be instituted and, during 1936, trials were carried out using sodium chlorate and "Weedex" a proprietary weedicide. Because of the reduced fire risk with the latter, the total area was sprayed with a 12½ per cent. solution of this material in December, 1936. Successive sprayings were carried out in April and December, 1937, and in April, 1938, using the same strength. These treatments resulted in the destruction of the aerial growth of the plants thus preventing the formation of seeds, but, after some months, considerable regrowth was noted in all instances due to the failure of the weedicide to destroy the vigorous root system of the plants.

During this period, and for several years, grubbing and pulling were insisted on by the road board on private properties, which were infested, but it was finally apparent that little success attended these efforts. Examination of the infested areas some time after grubbing and pulling had been carefully carried out, revealed small sections of the roots of the plants which had been removed still persisting and throwing out strong leaf and stem shoots below the surface of the ground. By the following season little diminution of the total stand was apparent. Similar results were obtained on a trial area, on light sandy soil at Karridale.

The fifth spraying was carried out in November, 1938, and "Atlacide," a weedicide containing calcium and sodium chlorates and calcium chloride, was substituted for "Weedex." "Atlacide" was used as a 12½ per cent. solution, to which a small amount of "Agral 3" was added as a wetting and spreading agent. The actual rate at which the spray was applied is somewhat difficult to arrive at owing to the scattered nature of the infestations precluding the possibility of accurately measuring any particular area treated, but an estimated rate of 150 to 200 gallons of solution per acre, is arrived at by taking the total quantity of spray prepared in relation to the estimated area upon which the plants were growing. The material was applied from a 200 gallon tank on transport, with a semi-rotary pump which was connected to adjustable nozzles by two twenty feet lengths of hose. Knapsack sprays were used in order to reach areas not accessible to the transport.

The strength of the solution was reduced by 7½ per cent. during the treatment carried out in May, 1939, without a reduction in the effectiveness of the spraying, and this application was persisted with, with two treatments per year, until December, 1942.

The period from December, 1936, to December, 1942, during which time 13 separate sprayings were carried out, was typified by a substantial diminution of the vigour of the infested areas, and in addition showed some reduction of the

total area, although no single site was rendered entirely free of the weed. This meant that the same distances had to be travelled during each treatment resulting in little saving in time each year. Seed formation had been prevented during the period however, but it became apparent that the seed of St. John's Wort remained viable for long periods under south-western Australian conditions, as a fresh crop of seedlings appeared each year on the treated areas. It has been reported that the seed of this plant may germinate after a period of fifteen to thirty years.

Results at this stage indicated that, while a measure of success in eradication was being obtained and control had definitely been established, it would necessitate prolonged and costly sprayings with "Atlacide" to ensure final eradication. In view of this fact an experiment was laid down in Margaret River, using common crude salt at the rates of five tons and two and a half tons per acre. A very favourable result was obtained from the plots treated at five tons per acre, and no permanent effect on soil fertility in this 45 inch rainfall was noted. Natural grasses and some minor clovers appeared on the plots during the following year. The plots treated at the rate of two and a half tons per acre did not give a relatively satisfactory result.

An application of five tons of salt per acre was adopted in successive treatments in October, 1943, and in September, 1944. A recommendation was also made to occupiers of infested lands that the application of two to three pounds per square yard, or a good-sized handful to each plant be made in preference to the grubbing and pulling previously insisted on by the road board, and a quantity of salt was made available, at cost, for this work.

During the 1945-46 active growing period, two treatments were carried out, the main one during October, and a "follow up" was applied during January, 1946, when the plants were in full flower.

At the time of writing, i.e., after treatment with crude salt over a period of three years, it is now apparent that salt is completely effective in every instance where every plant, or every compact area receives salt at the rate of five tons per acre. The limiting factor in ensuring final, complete eradication will be the extreme difficulty which is encountered in the finding and treating every plant. This is most evident in the case of the oldest, and, probably the original infestations of Karridale, where plants are widely scattered and are growing among low scrub and dense bracken fern. The only solution to this problem appears to be repeated inspection and the application of several amounts of salt each year, during the flowering period in December and January, in order to locate the plants missed in previous treatments. In several instances compact areas which have been found on vacant blocks have been reduced by one application of salt, to the stage when it is only necessary to follow up with a few pounds of salt each year in order to kill odd seedlings on the outskirts of the salted area.

Subsequent to the reclaiming of a number of previously vacant blocks in the Karridale-Kudardup area, in connection with the Land Settlement Scheme, at least eight areas of varying size have been discovered after the completion of the 1945-46 treatment and it is reasonable to assume that further patches will be encountered as the work on these blocks proceeds. Arrangements have been made for these areas to be located, and listed for future treatment.

SUMMARY AND CONCLUSIONS.

(1) Under the south-western Australian conditions, St. John's Wort has demonstrated its ability to assume the role of a major noxious weed as in other States of the Commonwealth.

(2) It has proved an extremely tenacious plant, the final eradication of which is difficult. Treatment must e repeated over a numer of years particularly where infestations are scattered over relatively large areas.

(3) Early treatment of large infestations at Karridale, Augusta and Margaret River, with firstly "Weedex" and secondly "Atlacide," prevented seed formation for a number of years, and reduced growth and vigour to a stage where it was possible to treat the areas with crude common salt.

(4) The use of common salt has proved satisfactory in obtaining the final eradication of certain areas, particularly where growth is dense and confined, rendering it possible to treat effectively the entire area.

(5) From information gained following the preparation of previously abandoned blocks in the Karridale-Kudardup area, for soldier settlement, it has been established that the incidence of St. John's Wort is more widespread than was thought previously, and increased efforts will be necessary to bring about total eradication. This recent information confirms the belief that the plant has been widely distributed per medium of grazing stock, and it is not unlikely that patches will be found along the stock route between Karridale and Nannup and Bridgetown.

(6) Results to date indicate that it will necessitate several years of concentrated effort before the infested areas can be reported as "clean."

A Simple and Efficient Method of Rearing Queens.

By L. Blair, Government Apiculturist.

IN rearing queens it is always necessary to remember that queens are only reared in nature when conditions are suitable, and that is when there is an abundance of nectar and pollen coming into the hive. The exception being in case of accident or a queen being incapable of carrying on her duties, when the bees will build supersedure cells to replace a lost or failing queen.

Young life needs two essential conditions, warmth and good food. Therefore, it is essential before starting to rear queens to have your queen rearing colonies packed with young bees with plenty of nectar and pollen in the hives and also coming into them freely.

A number of apiarists get discouraged when rearing their own queens with their lack of success, and give the job up in disgust. Hereunder is outlined a method that should overcome most of the difficulties attending the old methods of transferring young larvae into prepared queen cells, with its attendant pitfalls.

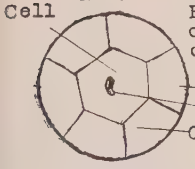
Remove queen from the hive selected to rear queens in, also all frames containing young larvae and leave for a period of five or six hours before inserting the prepared frames. The removed frames of brood could be given to the weaker colonies in the apiary or a nuclei made with the queen and brood. The bees being deprived of their queen and young brood, accept the prepared cells readily and will feed them lavishly with royal jelly, and produce well-nourished and vigorous queens.

All that is necessary is a tube made of tin or sheet brass $\frac{7}{16}$ in. in diameter and about 2ins. long; sharpen the cutting edge of the tube. Place this over the selected cell containing larvae, or if preferred, an egg just prior to its being hatched (see Sketch 1). Heat this metal tube in hot water, remove, place over selected cell, and push right through the comb with a circular movement, then remove the selected cell from the tube by means of a round tapered stick that is too large to enter the cell too deeply and crush the egg or tiny larvae. When removed from the tube cut surplus comb from the bottom of selected cell, dip into hot wax a few times to get a coating of wax—taking care not to leave in hot wax too long thus overheating the larva or egg—and then adhere to bar or bars placed in centre of frame (see Sketch No. 8). One, two or three bars of cells could be used if required. Next open or expand top of cell with tapered stick being careful not to insert too deeply to damage larva or egg. Bars on frame are attached by drilling a small hole in each end of bar and through end bar of frame. Cut nail short to enable nail head to fit flush against end bar of frame.

OPERATIONS IN TUBE METHOD.

All appliances are easily made at home.

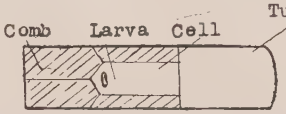
No.1



End view of selected cell after being cut out with Tube.

No.2

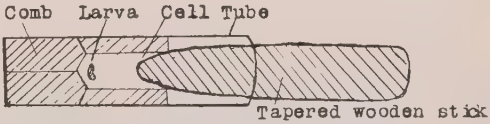
Side view of selected cell in Tube.



Selected cell unshaded with egg or young larva showing at bottom of cell.

No.3

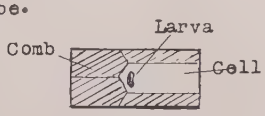
Side view of Tapered wooden plug to push out cell from Tube.



STICK small enough in shaft to move freely in tube. Parallel flat bottomed piece of wood can be used.

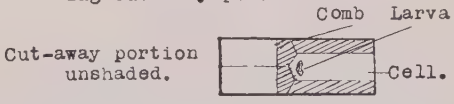
No.4

Selected cell after being removed from tube.



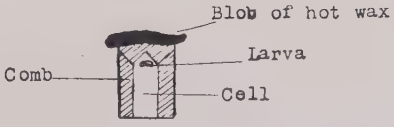
No. 5

Surplus cells removed from bottom of selected cell showing cut-away portion.



No.6

Cell ready to stick to bar.



No.7

Wooden Plug with cell in position ready for dipping into Hot Wax prior to sticking to bar.

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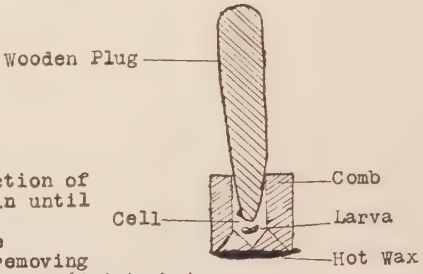
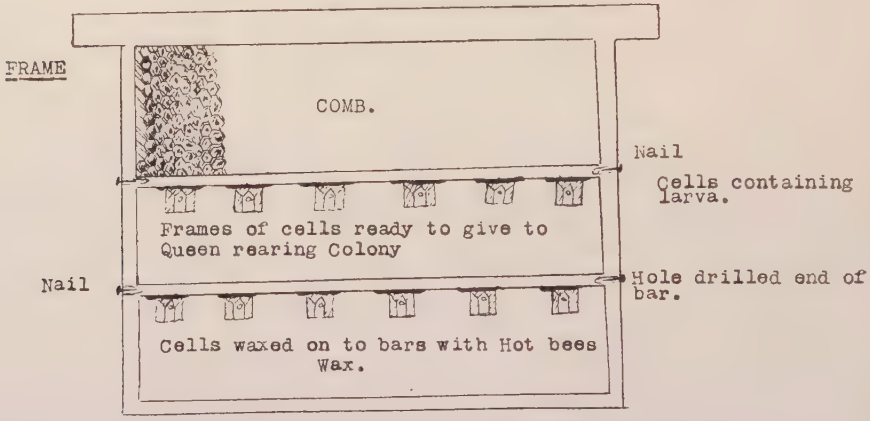


To dip, only leave in hot wax a fraction of a second then, when cooled, dip again until sufficient hot wax accumulates on bottom of cell to stick to bar. Use unengaged hand to steady cell when removing plug. Only immerse cell about 1/16th or $\frac{1}{8}$" into hot wax.

No.8

Side view of comb with cells attached to bars. Also showing method fixing bars in to frame with nail hole drilled through end Bars of frame and also into bars holding Queen Cells.



Tube can be made with a small piece of bright Kerosene or Petrol tin formed into a circular cylinder about $\frac{3}{8}$" or 7/16th", diameter about 2" long or longer if preferred, and sharpened at cutting end. It is not necessary to solder tube at joint.

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POINTS TO REMEMBER.

(1) First remove queen and young brood from hive five or six hours before inserting prepared cells. Otherwise queen cells containing larvae may be started and hatch out prior to the prepared cells and will result in the good cells being torn down.

(2) Choose eggs or larvae from hive or queen who gives the best record in honey production and has other qualities to recommend her such as uniform marking of progeny, breeding long lived workers, good clean housekeepers, good comb builders, or any other traits you wish to propagate in your stock. As soon as the frames of cells are prepared, place immediately in prepared hive, otherwise larvae may get chilled and prove unacceptable to the bees. If this should happen, give another prepared frame a day later.

(3) Place prepared frames between good solid frame of pollen and honey. Carry out all queen rearing operations when the temperature is over 75 degrees and in good light. See hive is strong with plenty of young bees and make sure

honey and pollen are coming in. Seven to 21 cells should be ample for an average hive to bring cells to maturity.

(4) Remember 90 per cent. of the breeding is in the feeding. Young life must have plenty of food and warmth.

(5) Ripe queen cells will be ready for transferring to nuclei or queenless stocks in the ninth or tenth day when the operator has used larvae under 24 hours old, and a day or two later if he has used eggs just ready to hatch. If there is any difficulty in choosing larvae of the correct age, better results may be obtained by using eggs nearly ready to hatch.

(6) When transferring ripe queen cells, do not put them in a very weak hive or nuclei, keep them warm right through their cell life. Many a good queen is chilled just prior to her cutting her way out of the cell and ruins her chances of proving her quality.

(7) Always remember to leave a ripe queen cell in the hive that has just reared a batch of queen cells or if preferred, the old queen could be reunited to them. It would also be possible to divide this strong queen rearing colony into several nuclei with a ripe cell to each division. In that case it would be advisable to move divisions a couple of miles away or place in a shady spot and block entrance with grass for a few days until the bees have lost all desire to fly back to their previous location.

(8) Inspect cells a day after giving to queen rearing hive or hives to ascertain the number of cells accepted. Always have a few extra cells than actually needed.

(9) Inspect cells a day or so before ready to transfer. Make up nuclei ready to receive queen cells about a day before the cells are ready to be transferred. If possible make nuclei in an out apiary and immediately transport to apiary where queen rearing operations are being conducted. This eliminates the likelihood of the old bees in the divisions flying back to their old location, thus making the nuclei too weak to keep the new queen cell warm.

By following these instructions carefully, the majority of apiarists should be able to rear sufficient good queens to keep their apiaries up to date with good stock with practically no outlay for special queen rearing equipment.

Dairy Herd Improvement and Herd Recording.

M. Cullity, Superintendent of Dairying.

DAIRY farmers are turning their attention to means of improving the efficiency of their operations by increasing the output of their farms. They plan to do this by keeping better quality stock, by feeding them better, and by reducing the incidence of disease.

It is the intention of the West Australian Government—with some financial assistance from the Commonwealth—to inaugurate a Herd Improvement Scheme with the objective of assisting farmers with information which will enable them to carry out their plans. The first step is the re-introduction of Grade Herd Recording with which will be associated surveys of conditions and practices. Herd wastage will be among the first problems to be considered, while a basis for making sire surveys will be included in the scheme.

Herd Recording in this State dates from 1919 when the system of measuring the yield of pure bred cows was instituted. This has continued without interruption. The recording of grade or commercial herds commenced in 1933, but

on the outbreak of war difficulties arose and, in 1942, it was decided that the men who were engaged on this work could be more profitably employed either in the Army or on urgent public works: accordingly all activities among these herds ceased. During the past two seasons, however, there has been increasing interest among farmers and—with the easing of labour supplies—the time is opportune for a resumption of activities.

Although those who have been associated with the activities in the past are familiar with the advantages of recording and the actual results obtained, there are many who may not be aware of its value and importance. It is hoped that in the coming years it will be possible to interest these in the scheme with advantage to themselves and to the State.

In 1933, when recording of grade herds started, 4,000 cows were tested for an average yield of approximately 180 lb. of butterfat, while in the final year, 1941-42, the average of those units which had a complete year was 231 lb.

There thus was an increase in average from the first year of testing of approximately 50 lb. butter fat, which—considering that the cash cost to the farmer was 2s. 6d. per cow only—was a very profitable result.

There is nothing magical about testing. The mere fact that a cow's milk is weighed and the amount of butter fat therein estimated does nothing to make her a better cow. Testing merely gives the farmer information on which he can plan intelligently to improve the output of his herd. The measurement of yields is not an end in itself, but is only a first step in approaching the objective of more intelligent and profitable dairy farming. It is the application of business method, which can be successful only if the farmer is prepared to study the records, plan, and make the effort to put his plans into operation. In other words, the improved results which I have quoted during the earlier period of herd recording were obtained only because the farmers concerned were prepared to use the information given to them as a basis for culling, for the selection of young heifers, and also in evaluing the worth of their bulls. These steps are the commonly known ways in which herd recording is used. There are others. It is no exaggeration to say that an improvement of 40 to 50 lb. butter fat per cow could be achieved in this State by improved feeding. I do not mean to infer that the purchase of concentrates is the means of better feeding, but a better use of pastures by adequate fertilisation, sub-division, a proper adjustment of the numbers of stock, the provision of a suitable number of watering points, combined with the conservation of sufficient hay and silage will allow full feeding of the herd with the minimum of expense for purchased feed. The regular testing of the herd enables the farmer to appreciate fully the variations in production which follow changes in feeding, and so helps him fix on those methods which suit best the conditions of his farm. It brings about better feeding, more thorough milking and keener management of the herd, the pastures and the farm.

The monthly visit of the recorder is in itself a stimulus to greater interest. It provides an opportunity for the farmer to discuss some of the problems confronting him and to make comparisons of his methods of feeding and management with those of other farmers.

It has been shown on various occasions in the past that the farmer who submits his herd for testing regularly enlists more readily in time of need the support of the banker, mortgagee or other creditors. This is due to their appreciation of the value of the service. Not the least important advantage which has come from herd recording has been the accumulation of data which has had an influence on the average management of herds. Probably the best demonstration of this is the evidence accumulated over a period of years that early calving is

profitable. The study of over 41,000 lactations has shown that highest productions have been given by those cows which calved during the months of April, May, June and July. The consistency of the results over the whole of the dairying districts was remarkable. There were some variations. For example, in the south coastal districts it may be expected that no loss of yield would follow calving in July and August. In the irrigation areas, the data shows that where there is ample green feed during the summer month, the differences in yield according to the month of calving are not so great.

The collection of additional data can give information bearing on other aspects of management, and it is intended that in the new scheme an extended service will be given in this way. It has been said by some farmers in the past that the recorders want too much information, and that they, the farmers, are content with knowing the comparative yields of their cows.

This is not a progressive outlook, and no apology will be given for asking the testing farmers for still more information. The cost of testing is considerably higher than the charge to the farmer, and it is unlikely that they will be reluctant to assist with the evidence which will benefit their industry generally.

In the future an effort will be made to obtain some reliable evidence regarding the causes of wastage in dairy herds.

Farmers find that the average working life of a dairy cow is relatively short. Some cows stay in the herds for many years, while others are culled quickly. The causes of losses in the herds are briefly—deaths, sales of low producers and sales or destruction of stock unsuitable for dairying on account of disease, such as tuberculosis, actinomycosis, contagious abortion, mastitis, or sterility.

Up to the present there is no evidence to indicate how serious these losses are. Individual farmers are known to have been made almost bankrupt by sudden storms of abortion, mastitis and sterility, but there is no means of calculating the annual cost to the industry. Some preliminary wastage figures which were collected in this State during 1941-42 and a survey conducted in the Brunswick district for some years earlier showed that there was an annual wastage of approximately 17 per cent. The average wastage as shown by herd testing reports for New Zealand for the five years 1938-43 was 16·8 per cent. It may be assumed for the purpose of making an estimation that the causes of wastage in the two countries are very similar. It has been calculated that the annual loss in New Zealand due to mastitis is £1,250,000, while that due to abortion is £500,000. New Zealand has approximately 14 times more cows than West Australia, and if the incidence of those diseases is about the same the annual costs to West Australia are estimated to be £90,000 and £36,000 or a total of £126,000 for these two diseases only.

There is thus a new real object in having this wastage information. It will indicate the various causes in their relative importance, and it is direct and convincing evidence of the seriousness of the position and can be used as a basis for a proper approach to attack it. As an indication of the value of a direct attack on a disease, the saving in New Zealand resulting from the vaccination of heifers against brucella abortus has been calculated—from the evidence of a reduction of the incidence of abortion in two-year-old heifers to three per cent.—as being £250,000. If the same incidence existed in West Australia and the same reduction in abortions occured following vaccination, it would mean a saving of nearly £18,000 per annum.

The urgency of collecting this data, therefore, may be readily understood.

It is intended also that with the new scheme provision for the issue of sire surveys will be made. It will not be possible to do much in this way until after two or three years' testing, but the necessary preliminary step will be taken in the marking for identification of all heifer calves and the keeping of a register, so that later when these calves come into production it will be possible to segregate their production records according to the sires, and in comparison with the yields of their dams.

So far, in the history of the dairying industry in this State, reliance has been placed—for the selection of bulls—on the performance of the nearest female ancestors, and it is certain that this policy has been successful. That the dairy farmer of this State probably has a keen appreciation of the value of continuity of breeding from standard bulls of one pure breed is demonstrated clearly by the fact that over 80 per cent. of our dairy bulls are pure bred. The method used is that known as "grading up" to a pure breed and the results can be seen in most herds. However, as the quality of herds improve, it becomes increasingly difficult to find bulls which will continue the improvement and therefore it becomes necessary to find bulls which are proven to beget daughters which are better than their dams. The continued use of these bulls will enable the general quality of the herds to rise.

The new scheme will commence in May and already there is ample evidence of the desire of a large number of farmers to participate and gain the information which will enable them to improve the efficiency of their operations.

Herd recording is not a competition between farmers, districts, or States, and therefore the present low production is the most urgent reason for putting a herd under test. The greatest and most rapid benefit will be obtained by those whose herd averages are low and who desire to apply themselves intelligently to the task of improvement.

RULES GOVERNING THE FORMATION AND OPERATION OF THE WEST AUSTRALIAN HERD IMPROVEMENT SCHEME.

1. The Superintendent of Dairying shall control the formation and administration of the Herd Improvement Scheme.

2. The State shall be considered as one Herd Recording Association.

3. Units within the association may be formed and conducted in suitable centres in dairying districts, and shall be in compact areas so as to avoid lengthy travelling by the Herd Recorder in carrying out his duties. Each unit shall contain approximately 20-25 dairy herds, comprising a total of not less than 350 cows.

4. Each unit shall be given a letter for identification and recording purposes.

5. Every member shall undertake to effect the culling from the herd of all cows which, having reached the age of six years, have failed in each of two lactation periods to produce 150 lb. of butter-fat.

6. Each member of a unit undertakes that, within three (3) years from entering his herd for recording, he shall own a pure-bred bull ex a cow which has achieved the standard for production prescribed by the rules of the Pure Breeds Herd Recording Scheme.

7. Members shall undertake not to rear any bulls to be sold for use as sires in dairy herds unless they are ex pure-bred cows and sired by pure-bred bulls.

8. Only Herd Records in the employ and under the direct control of the Department of Agriculture shall carry out Herd Recording under this scheme.

9. The official recording year shall cover the period from 1st May to the following 30th April. New units may be formed to commence operations at any period between 1st May and 31st October, and in such cases the period of the test shall be from the actual date of commencement to the following 30th April.

10. *Application for Herd Recording.*—Dairy farmers who desire to become members of the Herd Improvement Scheme and to join a unit are required to make application annually by 15th April each year on "Application Form for Testing Herd" G.H.R. form No. 2.

11. *All cows to be tested.*—Members are required to submit for testing every cow in their herds.

12. *Fees are payable as follows*:—

(a) The fee for herd recording shall be 2s. 6d. per cow per lactation period, the minimum fee being £1 5s. (i.e., fees for 10 cows).

(b) The full fee of 2s. 6d. shall be paid on the estimated number of "A" class cows to commence their lactation period by 31st October each year. When any variation occurs between the estimated and the actual number tested, the fees shall be adjusted annually.

(c) Waiving of fees in certain cases—"B" class cows. Although all cows milked *must* be submitted for test, the following may be recorded as "B" class cows. They must, however, receive this classification at the time of their first test.

i. Cows which have aborted.

ii. Strippers.

iii. Sick cows.

These cows are not charged for unless they reach 150 lb. of fat by 31st December.

iv. Nominated cows. A nominated cow is one which has calved normally but which at the time of her first test is nominated for culling. No charge is made for testing if the cow is out of the herd by 31st October.

Cows other than those mentioned above are "A" class cows, for which fees are payable.

(d) Fees for cows calving after 31st October.—The fee for cows purchased or those cows calving after 31st October in any year shall be 2s. 6d. per cow, and shall be paid as soon as testing is commenced. No further fee, however, shall become due for these cows until the next lactation period commences.

(e) Method of payment of fees.—The recording fee of 2s. 6d. shall be paid on application for the testing of a herd. Where, however, this is not possible, the sum of 1s. 3d. per cow shall be accepted with application for testing, and balance, 1s. 3d. per cow, being covered by a procuration order on a dairy produce factory payable within three months from date of issue, such order to be given at the time of application for testing.

(f) Herds exceeding 30 in number.—Where the herd submitted for testing exceeds 30 in number the number of cows exceeding 30 need not be paid for on application, but fees for same shall be paid before 31st October or as they enter the test, whichever date is the earlier.

Example.—A herd of 40 cows is submited. The owner may pay fees for all the cows if he desires, or he may pay the fees for 30 only, the fees for the remaining 10 cows being paid as they enter test, but payment must be completed by the 31st October. The fees paid on the 30 cows may be the full 2s. 6d. per head, or 1s. 3d. with a procuration order for the balance of 1s. 3d. per head on a dairy produce factory as per Rule 12e.

(g) For the purpose of assessing fees due to the association every cow which has been tested *once* shall be deemed to be a cow submitted for test.

(h) Recording or membership fees will not be refunded to a member after the first test of his herd has been carried out. If a member discontinues testing after the first and second test, he must continue to pay the instalments on full fee charged for each cow entered for test except with the approval of the Superintendent of Dairying.

13. *Identification of cows under test.*—The Herd Recorder shall be supplied with the following details of each cow in each member's herd: Age, colour, marks and/or brands, date of calving, sex of last calf, and also the pedigree to the extent known.

14. The following means shall be adopted to identify cows under test:—

(a) Members may have their cows individually marked for identification by tattooing in the right ear with two letters and a numeral, indicating the unit, the herd and the individual animal in that unit.

(b) Where members do not require individual identification of their cows, they shall when requested by the recorder, place in the milking shed a list with a description of all cows in the herd.

(c) Should difficulty be experienced by the recorder in recognising individual cows, he may request that individual identification as in (a) be adopted, and in such case the farmer shall give assistance in so marking the cows.

(d) Where cows have been tattooed for identification when submitted for test, as when bearing the number allotted in another unit, or purchased cows already bearing an identification mark for herd book purposes, no further identification marks are necessary.

15. *Identification of heifer calves*:—

(a) All heifer calves the progeny of "A" class cows under test shall be marked to enable individual identification.

(b) A witnessed declaration must be given in support of calf identification. If the owner is not actually caring for the herd, the declaration must be signed by the person doing this work and endorsed by the owner.

(c) The method of identification shall be as set out in rule 14a, but with the addition of a letter in the left ear to indicate the season of birth. The season commences on 1st May in each year and extends to and includes 30th April following.

(d) The calf must be marked as soon after birth as possible, preferably on the visit of the recorder following the birth of the calf.

(e) No calf shall be marked after it reaches the age of 12 months.

16. *Sampling of milk.*—The Herd Recorder shall weigh the milk yielded by each cow at each milking during the period of his visit, and shall take fair samples of each cow's milk at the rate of 1 c.c. for each pound of milk yielded at two consecutive milkings, and, after thorough mixing, shall ascertain by the Babcock method the butter-fat content of such milk. All calculations made in computing the test shall be recorded only in pounds of milk and pounds of butter-fat.

17. *Herd Recorder to give check sample.*—The Herd Recorder, when requested, shall give to the member a check sample of milk at the same time as he takes his own sample for testing.

18. *Farmer provided with daily record sheet.*—The Herd Recorder shall after each testing day, leave with the member a record or day sheet (G.H.R. 4) setting out the production of each cow for the day, and the progress production of each cow from the date of entry to test.

19. *Abnormal tests.*—In cases of cows appearing to be in normal health, but testing abnormally owing to being out of condition at time of testing, such tests shall not be registered, but an average made from the proximate and succeeding tests. When the yield of butter-fat during the 24 hours' test differs by 25 per cent. from the preceeding test, such test may be reated as abnormal. Any such sickness or abnormality shall be noted by the Herd Recorder and shown in the "remarks" column. Where the first test is abnormal, the Herd Recorder is authorised to credit such cows with milk and butter-fat production over a period of 60 days, such credit to be based on the results of the second test.

20. *Periods of recording.*—The lactation period shall consist of nine sub-periods covering respectively eight sub-periods of 30 days and one sub-period of 33 days (*vide* Rule 22). Each herd in an association shall be tested once every 30 days approximately, except during April. If it is found impractibale to make a test 30 days after the preceding test, such test may be taken not less than 25, nor more than 35 days, after the last test. The order in which the herds are tested shall be decided by the Herd Recorder.

21. No cow shall be tested unless five (5) clear days (120 hours) have elapsed since calving.

22. *Cows commencing test more than 30 days after calving.*—In cases where owners are commencing to test their herds for the first time, or where it has been found impracticable to test certain cows until after they have calved for a period of three months or more, the Herd Recorder is authorised—if he is satisfied regarding the date of calving—to credit these cows with milk and butter-fat production as shown hereunder, such credit to be based on the first 24 hour test made by the Herd Recrder.

No. of Days elapsing between calving and first test.	Period of Production credited on first test. (Days.)	No. of Tests required for 273 days lactation period.	Method of arriving at the ninth Sub-period (33 days).
5–14	30	10	Average 9th and 10th tests.
15–44	30	9	Treat 9th test as normal Sub-period.
45–74	60	8	Treat 8th test as 9th Sub-period.
75 and over	90	7	Treat 7th test as 9th Sub-period.

23. In compiling the annual report of the average production of the herd, exemptions may be allowed for such cows as have been sold, or have dried off owing to accident or sickness prior to the third testing period, also for heifers calving under 18 months of age.

24. *Production certificates.*—

(a) Certificates of production for cows which have completed their lactation periods should be made available to the owner as soon as the test is completed on the G.H.R. Form 3.

(b) Where cows have been marked individually for identification the marking must be shown on the certificate.

(c) Where marking for identification has not been used a description of the cow should be given on the certificate followed by the words, "not marked for identification."

25. *Reports to be furnished by the Herd Recorder.*—The Herd Recorder shall forward to the Superintendent of Dairying, Department of Agriculture, Perth, the following reports on the forms provided.

(a) Monthly report showing the average yield of milk and butter-fat per cow and the number of cows tested in his unit.

(b) Monthly report giving details of heifer calves marked during month.

(c) Quarterly report at the end of July, October, January and April, showing the average progress yields of each herd in his unit.

(d) Quarterly wastage report at the end of July, October, January and April, showing the number of cows which have died, or have been culled from the unit under the headings set out on the forms provided.

(e) Annual summary of the unit.

(f) Annual production report for each herd in the unit.

(g) Annual month of calving report showing the number of cows calving in each month, and the average annual production according to the month of calving.

(h) General report describing the work and any factors which have influenced production during the year.

(i) Such other reports which in the opinion of the Superintendent of Dairying are necessary for the benefit of the testing members or for the efficient operation of the Herd Improvement Scheme.

By Authority: WILLIAM H. WYATT, Government Printer, Perth.